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PRODUCTION AND MARKETING STRATEGIES FOR
UTILIZING BEETLE-KILLED AND
ASSOCIATED FRONT RANGE TIMBER

FINAL REPORT

PRODUCTION AND MARKETING STRATEGIES FOR UTILIZING BEETLE-KILLED
AND ASSOCIATED FRONT RANGE TIMBER

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and Range Experiment Station
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PRODUCTION AND MARKETING STRATEGIES FOR UTILIZING BEETLE-KILLED AND ASSOCIATED FRONT RANGE TIMBER

The Problem

Region 2 of the U.S. Forest Service and the Colorado State Forest Service have identified the mountain pine beetle epidemic in the Front Range area of Colorado as one of the most urgent forest management problems in the region. In order to develop workable management programs to control the beetle epidemic, means must be found to utilize salvage and green timber that needs to be removed to put the stands in a healthier, less susceptible, growing condition. Outlets for this raw material need to be developed and the potential market areas must be determined for Front Range wood and fiber products. Currently the lack of such information is an impediment to generating suitable industrial capacity and to developing necessary courses of resource management for long-term beetle control.

Introduction

The mountain pine beetle (*Dendroctonus ponderosae*) is currently in outbreak status in Front Range ponderosa pine stands. A U.S.D.A. Forest Service report entitled, "Western Forest Insect Problem Analysis" estimates that an annual mortality of ponderosa pine amounting to 27.3 million cubic feet is caused by the mountain pine beetle in the area. These losses are expected to continue or possibly increase if nothing is done. An effective, long-term control program to reduce these losses should include salvaging the infested trees along with improving the growing condition of the "susceptible" forest. Research (Wygant, 1959; Sartwell and Stevens, 1975; Stevens, et. al., 1975) has indicated that most beetle infestations are in overcrowded, mature or over-mature, less vigorous stands. The Front Range has vast acreages of these type stands, since the forest has been protected for decades from fires which previously caused natural thinnings. Thus, the susceptibility of the forest to insect damage has increased over the years to the point where preventive action must be undertaken to eliminate catastrophic losses in timber, scenic, and watershed values. In order to prevent continuing infestations, the health and resistance of these stands needs to be improved through a large scale sanitation and thinning

program. To be possible, this control program needs to be economically feasible and a market should exist for the harvested raw material and the associated wood products. Otherwise, there will be problems in acquiring funds to do the thinning and problems in disposing of the material removed.

Study Objectives

This study has two objectives:

- 1) to define the market potential for wood products produced from raw materials potentially available in the Front Range area of Colorado,
- 2) to identify and evaluate alternative production and marketing strategies for utilizing wood raw materials generated through beetle control programs.

Methodology

The study involved several phases including 1) identifying the potential market area, 2) identifying characteristics of the market areas relating to consumption of forest products, 3) developing and testing alternative production and marketing strategies based on the raw material available, identifying the capacity of an area to produce each product, and 4) relating the suggested strategies to a mountain pine beetle control program for the Front Range area of Colorado.

Much of the information developed during each phase is analyzed and presented on a case study basis for each processing center.

Identification of Potential Market Areas

Potential market areas were determined for six processing centers along the Front Range. These processing centers included Fort Collins-Loveland, Boulder-Longmont, Denver and Suburbs, Pine-Bailey, Colorado Springs, and Canon City-Penrose-Florence. The selection of processing centers was based on the following criteria: 1) existence of and current capacities of the local timber industry, 2) presence of transportation network suitable for use by forest products industries, 3) accessibility to timber stands. The marketing area for all of these processing centers was located to the north, south, and east of the Front Range. In general, the market area went as far south as New Mexico, as far north as Wisconsin, and

as far east as Ohio. This area was based primarily on where the mills in the Fort Collins-Loveland area were currently marketing the majority of their products. The Fort Collins-Loveland center when compared with other processing centers has by far the highest wood product production, the largest mills, and has the most distant markets. For these reasons, the marketing area for this processing center gives a good indication of where the other processing centers could potentially market their products. (see Figure 1)

The marketing area for each processing center was divided into 5 zones. These zones were 0-5 miles, 5-80 miles, 80-200 miles, 200-900 miles, and 900-1300 mile distances to major population centers. The zones represent the distance where certain products could be profitably marketed given the product value and transportation costs considered. Not all products could be profitably marketed in every zone of the entire market area. Lower value products were generally marketable only a short distance, while higher value products, able to absorb transportation costs, could reach more distant zones. Table I lists all products currently produced along the Front Range.

Since the raw material includes all timber that could be harvested in the timbershed, products produced from spruce-fir and lodgepole pine were considered along with products made from ponderosa pine. If the beetle-killed ponderosa pine had been dead five years or less, it was assumed to be suitable for almost the same products as live trees. A previous study, C.S.U. Project No. 2191, which evaluated the suitability of beetle-killed ponderosa pine for wood and fiber products has shown that ponderosa pine is suitable for almost all the products listed in Table 1. In most instances the use of beetle-killed wood is prohibited only in its use for higher grade levels of products due to structural imperfections and deterioration. Thus beetle-killed wood requires more selective

FIGURE 1 - Marketing Area for Fort Collins-Loveland Tributary Area
(Sample)

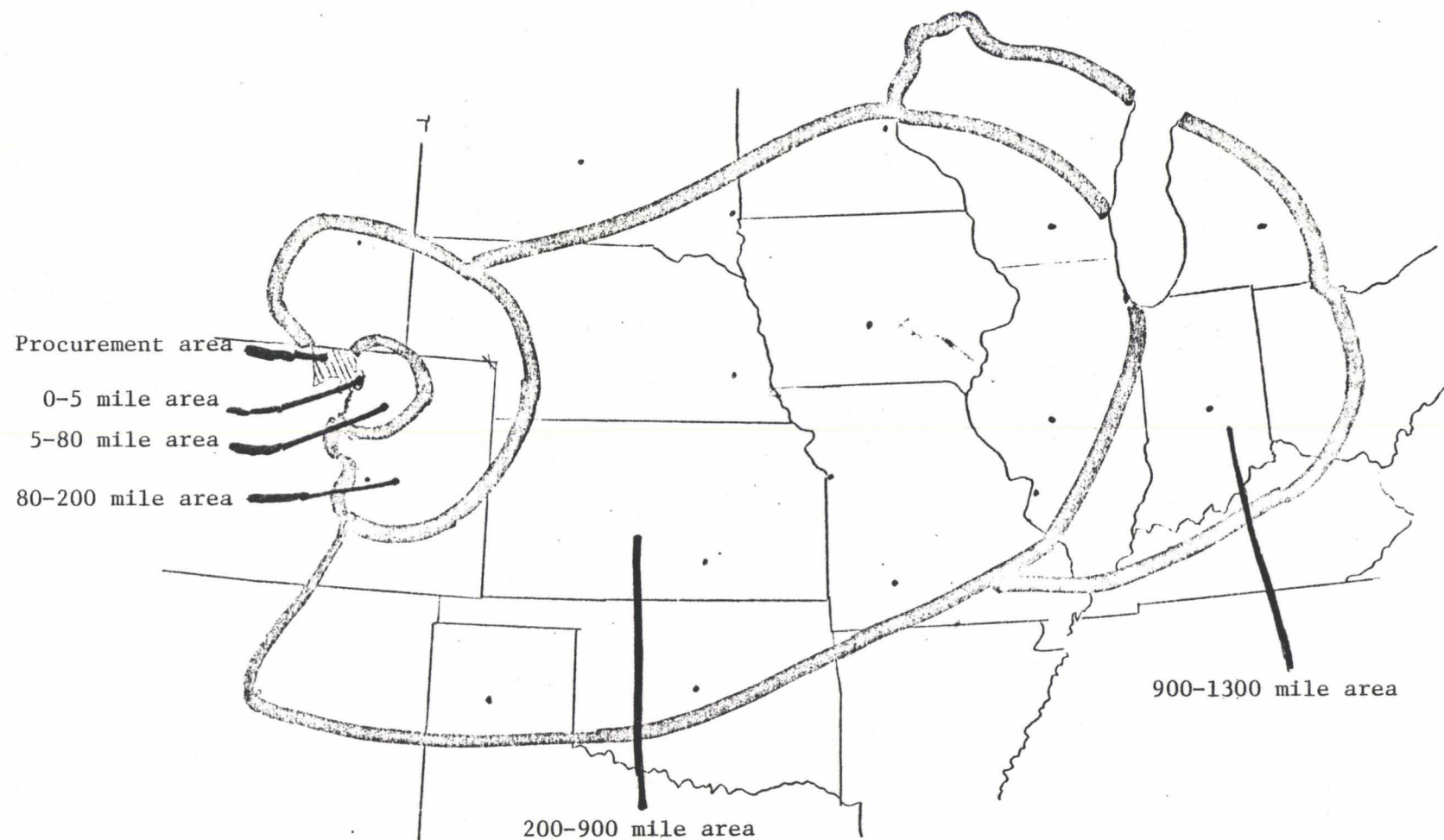


Table 1 - Currently Produced Front Range Products

<u>Product</u>	<u>Common Finished Size</u>
pallets	4' x 4'
timber (treated)	6" x 6" x 8'
timber (not treated)	6" x 6" x 8'
fencing	3" x 1" x 6'
boards (rough)	1" x 4" x 16'
boards (planed)	1" x 4" x 16'
houselogs (tongue and groove)	8" x 16'
houselogs (not tongue and groove)	8" x 16'
houselogs (tongue, groove, and planed)	8" x 16'
barn poles (treated)	6" x 20'
corral poles (treated)	3" x 16'
utility poles (treated)	8" x 12'
fence posts (treated)	3.5" x 6.5'
paneling (tongue, groove, and planed)	1" x 4" x 12'
dimension lumber	3" x 6" x 16'
studs (planed)	2" x 4"
railroad ties (treated)	6" x 8" x 6'
railroad ties (not treated)	6" x 8" x 6'
firewood	4' x 4' x 8' (cord)
beams (planed)	4" x 4" x 16'
wedges	1" x 4" x 6"
dunnage	4' x 4' (each crate)
chips	
shavings	
sawdust	

examination of pieces of most products. These products will have slightly lower product values and higher logging and processing costs.

Marginal Analysis

A marginal analysis was conducted for each product in each processing area to determine the profitability of each product in a marketing zone. The following equation was used for this analysis:

$$MR - MC - (P + R) = r$$

Mr = marginal revenue = wholesale price of product

MC = marginal cost = stumpage, procurement, milling, and transportation to the market costs

P+R = profit and risk, 10% of total marginal costs

r = residual

This equation was applied to every product that was currently being produced by the processing center. When 'r' was found to be less than zero in a marketing area zone, the product was considered uneconomical to market in that area. The results of this action are given in each individual case study. For many products it was determined that producers would expand their sales to more distant zones and still maintain a profit. Thus, the potential marketing area for many of the products was not being utilized. In a few cases a producer would even receive a greater profit for his product if sold at a greater distance, illustrating a gain in value over the additional transportation costs.

The economic data for the marginal analysis was obtained from informal mill discussions, U.S. Forest Service timber appraisals, and telephone conversations with wholesalers and retailers throughout the marketing zones in November and December of 1976. Discussions with mill managers was the primary source of information. The discussions provided information on products stumpage, harvesting, milling, and transportation costs. Telephone discussions with wholesalers in each marketing area zone supplied data on the current wholesale prices of wood products in each zone. When these methods failed to produce the desired information, U.S.F.S. appraisal estimates were used to obtain the data concerning stumpage, harvesting, and mill costs.

Marginal revenue is considered to be a function of wholesale price. These wholesale prices were collected for each product via telephone calls or in interviews with wholesalers and mills. The raw material species do vary in regard to structural characteristics, but when made into similar products and sold in the market place prices were approximately the same. However, there were a few important exceptions to this rule. Boards produced from spruce-fir and lodgepole pine did have higher wholesale prices than those manufactured using green ponderosa pine and ponderosa pine dead 5 years or less. This product is graded from #1 to #5 depending primarily on the physical and visual properties of the product. The higher the defect in the product the lower the grade and value.

The marginal cost per unit for each product was the sum of the stumpage, procurement, milling and transportation costs. Currently, poletimber generally sells at the U.S.F.S. "base rate" along the Front Range. The price of ponderosa pine poletimber was generally found to be \$2.00/MBF, \$3.00/MBF for lodgepole pine and spruce-fir, and \$.50/MBF for dead material, based on recent U.S. Forest Service appraisals. Sawtimber stumpage values vary greatly along the Front Range, ranging from a high of \$20 MBF to the base rate. For this reason the average sawtimber stumpage costs to the processing centers could only be estimated. The price of ponderosa pine sawtimber was determined to be \$3.00/MBF, \$4.00/MBF for lodgepole and spruce-fir and \$.50/for dead material. Spruce-fir and lodgepole pine have higher stumpage costs than ponderosa pine or the dead material because of the slightly higher product values and lower logging costs associated with this material.

Procurement costs for poletimber range less than sawtimber as the trees are smaller and require less equipment to log. Costs of logging poletimber were found to be \$39.40/MBF for spruce-fir and lodgepole pine, \$41.37/for ponderosa pine, and \$43.34/MBF for ponderosa pine dead 5 years or less, again based on U.S. Forest Service appraisals. The average procurement costs for sawtimber wood products were \$60.01 for spruce-fir and lodgepole pine, \$64.51 for ponderosa pine and \$69.01 for the ponderosa pine dead 5 years or less.

The costs of milling the raw material to a finished product was the most difficult data to obtain. U.S. Forest Service appraisals did not

consider the milling costs of each individual product but rather used an average milling cost. The costs determined were at best an average value of all the products produced along the Front Range. As few producers along the Front Range record cost data, this data was estimated in the following fashion. Based on information supplied from a few large mills concerning profit margins for certain products the following equation was designed: $M = WP(1-P) - (SC+PC+TC)$

M = milling costs

WP = wholesale price

P = profit margin - as a decimal (based on percentage)

SC = stumpage costs

PC = procurement costs

TC = transportation costs

Transportation costs were calculated for each product in each marketing area zone based on truck rates, not rail, as will be discussed at a later point. In the determination of the truck rate the average truck load was assumed to be 10 tons, or approximately 770 cubic feet of wood product. The average distance the products were sent in each marketing zone was determined based on quantity weights. For example, if 80% of a product was sent 60 miles its weighted distance was (.80) (60) or 48 miles. The remaining 20%, if sent 35 miles accounted for another 7 miles totaling 56 miles for that product. Transportation costs for the mileage was calculated using the following formula:

$$\begin{array}{l} \text{Product Transportation Costs for each} \\ \text{marketing zone per MCF} \end{array} = \frac{\text{cost of traveling the average distance} \\ \text{in each zone) (1000)}}{770 \text{ cubic feet}}$$

For example, if a product was sent to the 0-5 mile marketing zone for approximately 2 miles, at a rate of \$1.25 per mile the cost would be \$2.50. The cost per thousand cubic feet would be $\frac{2.50 \times 1000}{770 \text{ cf}}$ or \$3.25/MCF. A similar procedure was applied to all products in all marketing area zones.

As previously stated, truck rates were used for all the cost computations for all products. At present the mills utilize the less expensive truck rate over rail. Rail transportation only becomes economically feasible for shipments to 900 miles or greater. (see Tables 2, 3 and Figure 2)

Table 2 - Truck Transportation Rates¹

Minimum truckload: 24,000 lbs.

Product: planed lumber: 1 x 4

Denver, Colorado to:	<u>Dollars per cwt.</u> ²
Fort Morgan, Colorado (65 miles)	0.27
Julesburg, Colorado (180 miles)	0.54
Omaha, Nebraska (500 miles)	0.90
Chicago, Illinois (900 miles)	1.20
Columbus, Ohio (1,300 miles)	1.80

Denver, Colorado to:	<u>Fort Morgan, CO</u>	<u>Julesburg, CO</u>	<u>Omaha, NE</u>	<u>Chicago, IL</u>	<u>Columbus, OH</u>
(dollars/MBF) ³					
Lodgepole pine	\$ 4.50	9.00	15.00	20.00	30.00
Ponderosa pine	4.20	8.52	14.20	18.94	28.40
Engelmann spruce	3.92	7.86	13.09	17.46	26.19
Subalpine fir	3.59	7.19	11.99	15.98	23.98

¹Information provided through mill contacts December 1976

²One hundred pounds

³Price variance due to weight differential in species

Table 3 - Rail Transportation Rates¹

Minimum carload: 70,000 lbs.

Product: planed lumber: 1 x 4

Denver, Colorado to:

Dollars per cwt.²

Fort Morgan, Colorado (65 miles)	0.32
Julesburg, Colorado (180 miles)	0.62
Omaha, Nebraska (500 miles)	1.02
Chicago, Illinois (900 miles)	1.38
Columbus, Ohio (1,300 miles)	1.68

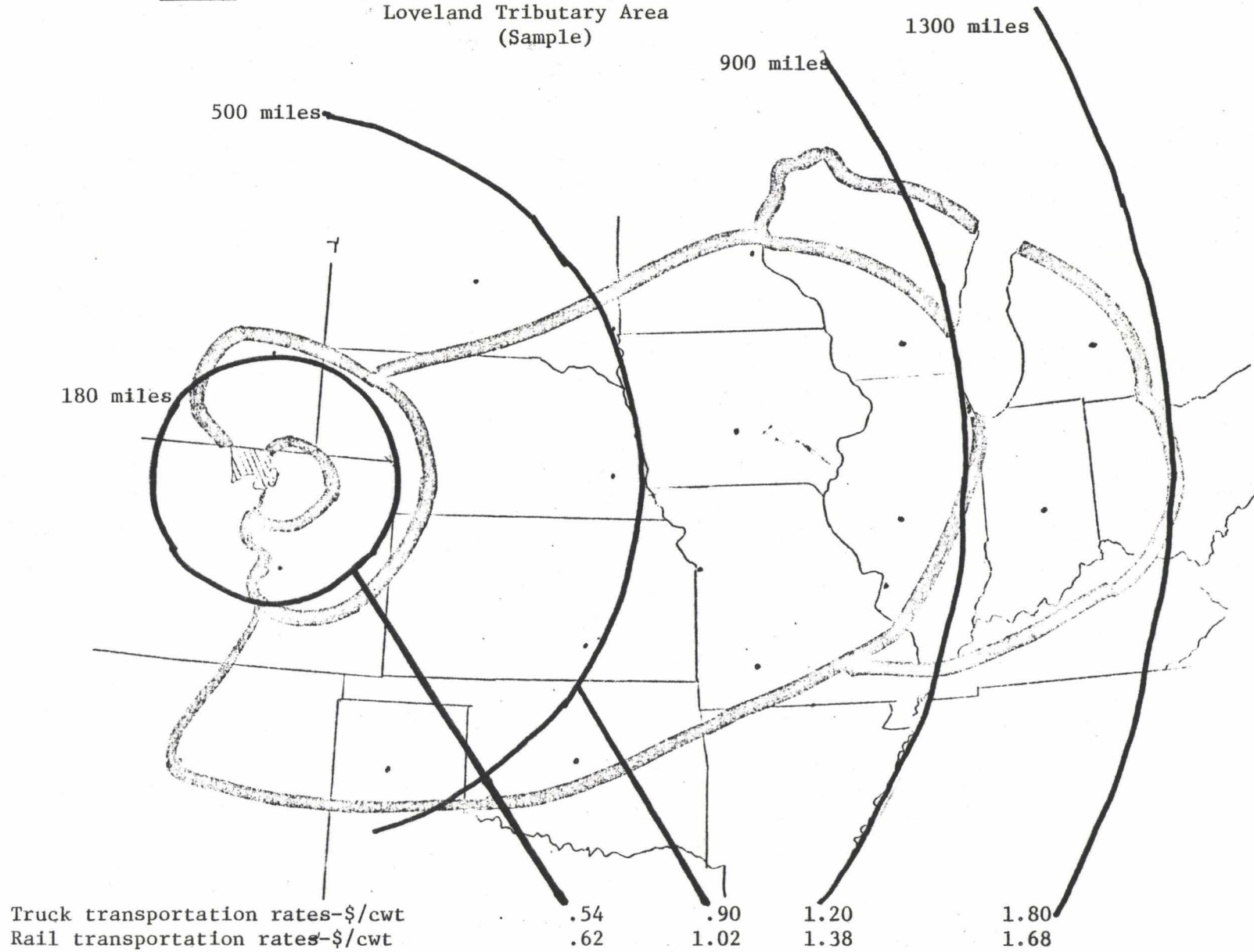
Denver, Colorado to:	<u>Fort Morgan, CO</u>	<u>Julesburg, CO</u>	<u>Omaha, NE</u>	<u>Chicago, IL</u>	<u>Columbus, OH</u>
(dollars/MBF) ³					
Lodgepole pine	5.35	10.37	17.00	23.07	28.08
Ponderosa pine	5.05	9.78	16.09	21.77	26.51
Engelmann spruce	4.66	9.02	14.84	20.08	24.44
Subalpine fir	4.26	8.25	13.59	18.38	22.38

¹Information provided by the Union Pacific Railroad, Denver, Colorado, March 1976.

²One hundred pounds

³Price variance due to weight differential in species

FIGURE 2 - Transportation Isocost Map and Marketing Area for Fort Collins-
 Loveland Tributary Area
 (Sample)



Alternative Production and Marketing Strategies

Alternative production and marketing strategies were developed through the use of a goal programming approach. The use of this program will allow development of a strategy that is optimal in its allocation of products to markets. The program does not attempt to simulate current marketing programs or conditions. A goal program was formulated for each processing center on a case study basis. The following represents a general approach to that formulation.

$i(1 \rightarrow m)$ = products produced at processing center

$j(1 \rightarrow 5)$ = marketing zones

$\bar{x}_{ij}$ = units of product i produced at processing center and marketed in marketing zone j .

$\bar{a}_{ij}$ = $\bar{b}$ - constraints concerning raw material supplies

$\bar{b}_{ij}$ = $\bar{c}$ - constraints concerning the product capacity or the current annual product production

$\bar{c}_{ij}$ = $\bar{d}$ - constraints concerning the economic residuals (MR-MC-P&R) for products in each marketing zones

A = linkage matrix to products

B = linkage matrix to products

C = linkage matrix to dollars/MCF for each product in each marketing zone

$\bar{b}$ = MCF of raw material

$\bar{c}$ = MCF of product capacity

$\bar{d}$ = dollars/MCF

(see Table 5).

For each of these constraints goals, priority levels can be established. For example, one might wish to incorporate two goals: 1) to remove all the beetle-killed timber that is dying each year, and 2) assure the mills a reasonable profit. As a forest policy decision you could decide that the initial goal is more important and thus in the goal program that goal will be met first, subject to the other constraints. Once this goal is attained as closely as possible, the program will concentrate on maximization of the producers profits while meeting this goal.

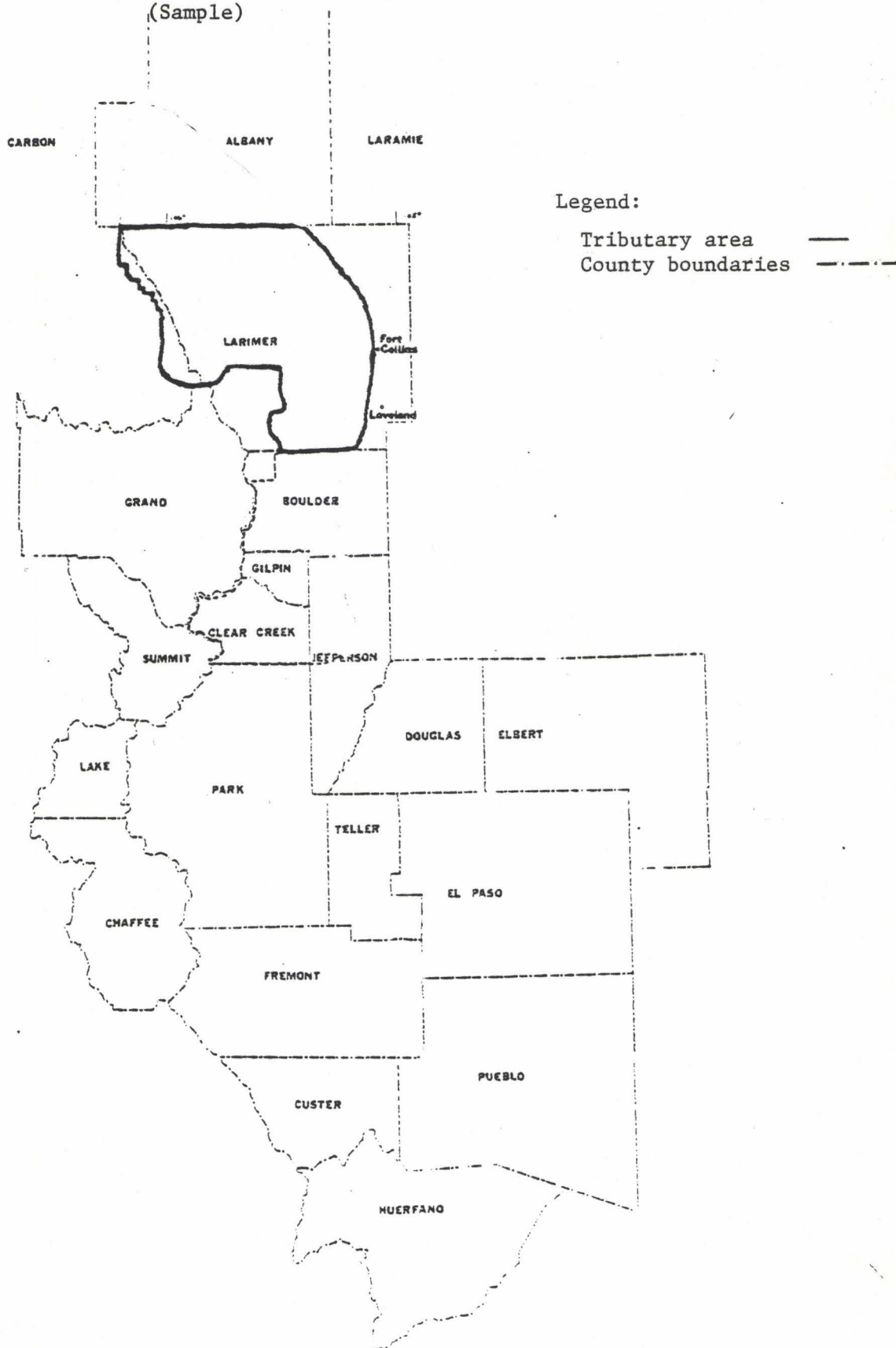
In formulating the matrix a few important assumptions were made. First, the time horizon is for one year. All values for $\bar{b}$, $\bar{c}$, and $\bar{d}$ are on an annual basis. Secondly, the assumption is made that one cubic foot of raw material

will result in one cubic foot of a finished product. A one to one conversion factor of raw material to finished product was used. Finally the assumption was made that if a product was produced it would immediately marketed to some marketing zone, thus eliminating inventory as a factor in our model.

Raw material supplies available and annual cuts within each procurement area were determined in the manner explained below. In estimating these areas the assumption was made that competition exists among the processing centers for raw material. It was further assumed that those processing centers which were closer to the raw material and had a greater product capacity would have a competitive advantage over those centers that were farther away and had less capacity. Taking this competitive advantage into account the procurement areas were determined in the following manner. The boundary designated in C.S.U. Project #2192 was used as a first estimate of the procurement area. This boundary was based on where the mills have gone or could go for raw material. The Project #2192 boundary assumes no competition among the processing centers for the raw material and as a result some overlap exists in the procurement areas for numerous processing centers. To correct for this overlap portions common to more than one processing center were designated to only one on the basis of competitive advantages. Thus all the raw material within a procurement area was considered available for only one processing center (see Figure 3).

Secondly, the number of forest acres and accessible commercial forest acres for procurement area was determined along with data on annual allowable cuts and current annual cuts for the procurement areas. Data was obtained from C.S.U. Project #2192 on recommended annual cuts in ponderosa pine. The recommended cut is based on an average estimated thinning schedule of 300 cubic feet per acre of ponderosa pine. The 300 cu ft./acre was multiplied by the acreages of ponderosa pine in state and private holdings. National Forest thinning volumes were determined with the aid of an accessibility factor and a thinning rate based on stand type. This total volume is harvested over a five year period in equal single year increments as listed in the recommended cuts within each case study summary. Finally, a cut on the dead ponderosa pine was calculated based on the assumption that all pine

FIGURE 3 - Fort Collins-Loveland Tributary Area
(Sample)



that had died the previous year would be removed. A cut for pine dead greater than five years, assumed to be used strictly for firewood, was based on the processing center capacity for firewood usage.

Current annual production rates were obtained to determine a comparative basis against which to measure strategies. This information was derived in the following manner: each processing center's mills and producers were questioned as to what products they produce and what their average daily production reaches. Based on the number of days the mills were idle or currently operating; 240 days/year or full time, 60 days/year or seasonal, each mill's annual current production was determined. The current annual production rate for each product in each processing center was the summation of each mill's output.

Maximum product capacity was calculated in order to determine the possible extent of mill utilization in the course of one year. This calculation was based on the assumption that all mills can operate 8 hours per day and 240 days per year and that the proportion of the products currently produced by the mills will remain the same if they operated full time.

Product capacity was considered an important constraint to the goal programming model in order to determine the possible extent of a raw material harvest. Even though it might be desirable to liquidate the beetle-kill pine in two years, for example, the limiting factor of product capacity may serve to extend the time frame unless processing capacity was increased or some other action taken.

Finally, the last factor considered in the goal program were the economic residuals discussed earlier. This information gives a good indication of what the producer's return is for each product marketed in each marketing zone. The same product will have a different residual when produced from a different species of wood. The mills will tend to produce those products where they can obtain the greatest total profit. Thus if it can be shown that a higher profit can be realized from products produced from ponderosa pine than from spruce-fir or lodgepole pine, the mills will be more likely to utilize ponderosa pine than other woods.

The above information was analyzed using goal programming to determine the tradeoffs and impacts of various alternative control programs. Four alternative control programs were considered for each processing center, each with different constraints, goals, and priorities. These alternatives were evaluated on a case

study basis. Based on these results an evaluation of the tradeoffs between the alternatives were made for each processing center.

The four alternatives considered for each processing center were as follows:

Alternate (1) Ponderosa pine thinning

Constraints

- Axij=b annual allowable cut constraints were placed on the spruce-fir and lodgepole pine raw material, CSU Project #2192 recommended thinning cuts were placed on the ponderosa pine, and annual cuts were applied to mortality ponderosa pine (pine that had died the previous year) and salable dead (timber dead greater than five years)
- Bxij=c product mill capacity constraints placed on each product
- Cxij=d economic residuals for each product in each marketing zone

Goals and Priorities

- #1 to minimize the underachievement on CSU Project #2192 recommended cuts on ponderosa pine
- #2 to maximize the processing centers profit for each product

Alternate (2) Ponderosa pine mortality cut

Constraints

- Axij=b annual allowable cut constraints were placed on the spruce-fir, lodgepole pine, and ponderosa pine raw material, and the recommended annual cuts were applied to the mortality ponderosa pine and salable dead
- Bxij=c a product capacity constraint was placed on each product
- Cxij=d economic residuals for each product in each marketing zone.

Goals and Priorities

- #1 to minimize the underachievement of removing those ponderosa pine that had died the previous year
- #2 maximize the processing centers profit for each product

Alternate (3) Producer's profit

Constraints

- Axij=b same as for Alternative #2
- Bxij=c same as for Alternative #2
- Cxij=d same as for Alternative #2

Goals and Priorities

- #1 maximize the processing centers profit for each product

Alternate (4) Current situation

Constraints

- Axij=b current cut constraints were placed on the spruce-fir, lodgepole pine and ponderosa pine raw material, and the recommended annual cuts were applied to the mortality ponderosa pine and salable dead
- Bxij=c current annual production for each product
- Cxij=d economic residuals for each product in each marketing area

Goals and Priorities

- #1 maximization of processing centers profit for each product

Alternative #1 analyzes the recommended ponderosa pine thinning from CSU Project #2192. It has a first priority goal of minimizing the underachievement of this cut and a second goal of maximizing the processing centers profit for each product. An important assumption for this alternative, as well as for the next two, was that there exist sufficient demand for products so the mills can operate at full capacity. Alternative #1 quantitatively addresses the following questions: 1) was thinning possible subject to the other constraints? 2) was this ponderosa pine thinning greater than the allowable cut on this species? 3) will the mills' profit margins be reduced if they cut more ponderosa pine and less spruce-fir and lodgepole pine?

Alternative #2 analyzes a mortality cut on the ponderosa pine. This cut is designed to remove only those trees that have died the previous year. It has a first priority goal of minimizing the underachievement of this cut and a second priority goal of maximizing the processing center's profit for each product. This alternative can be compared to Alternative 1 in response to the following: which cut removes the greater amount of raw material and which cut results in a greater profit margin for the mills?

Alternative 3 was much the same as Alternative 2, the difference being that the priority #1 goal was to maximize the processing center's profit for each product. By setting this as a priority #1 goal, only those products that maximize profit will be produced.

Alternative 4 was evaluated to compare the current situation with the other proposed alternatives. The processing center's current cuts and current annual production for each product were substituted for the allowable cuts and product capacity constraints. The first goal was to maximize the processing center's profit. Questions to be considered at this point would include: 1) how do the current cuts compare to the allowable cuts?, 2) how do the current cuts compare to the recommended ponderosa pine thinnings and mortality cuts?, 3) how do the current annual production rates compare to the processing center's product capacity?, 4) how do the processing center's current profit margins compare to Alternative 3?

Sensitivity Analysis

A great number of factors could be reviewed to determine their influences on the marketing of wood products from the Front Range. The supply of timber, if varied for any reason, would yield a different production, distribution, and net income character. Likewise, the production rate and costs of purchase, harvest, production, and transportation of product interact, resulting in a distinct goal program output. All of these factors and many others within the sphere of timber supply production and sales have the capability of altering the original set of results for each case study.

For this sensitivity study, demand limitation was chosen as a factor with significant inherent variability, and as that factor with the least certainty. As the program was designed for the initial four alternatives in each case study, several assumptions were utilized. These alternatives,

within the parameters of the goals and constraints, assume that any amount of product produced from the various sets of raw material will be consumed. Considering the extent of the determined marketing area, 0 - 1300 miles, the consumption or demand level is indeed great. As has been noted previously, the sale of a product may return a range of profits depending on the location of its final consumer. As this model is constrained to maximize producer's profits, many products will be allocated to those areas with the highest return per MCF of that product. Thus a given zone may inherit, due to the constraint, a supply of a product which exceeds the possible demand for that product.

This sensitivity analysis incorporates the use of a ten percent level of product production as the maximum consumption of any given product in the local marketing zone, 0 - 5 miles. Thus if a total of 200 MCF of pallets was produced as a result of an alternative strategy, the sensitivity analysis would assume only 20 MCF of pallets could be consumed in the 0 - 5 mile marketing zone. This consumption limitation is performed regardless of a product profit maximization which might have otherwise been realized. The results of this sensitivity analysis along with the results of the original four alternatives is displayed in the summaries of each case study.

Additional sensitivity analysis could ask or pose the following situations in an attempt to determine relationships in the supply-demand, profit-cost arena of wood products production and marketing on the Front Range.

- a) change in present mill capacities
- b) change in timber supply
 - 1. overall
 - 2. for a given species
- c) product production changes
 - 1. overall
 - 2. for given products
- d) number of, or types of mills changed
- e) change in cost factors
 - 1. logging
 - 2. transportation
 - 3. raw material
 - 4. milling

- f) change in product value
- g) addition of new product lines
- h) public sector subsidy of costs
- i) subsidy incentive for use of ponderosa pine

Recommended Production and Marketing Strategies

This last step consolidates the results of the goal programming analysis with other considerations concerning a beetle control program. The marketing problems relating to distribution, product quality and bias and prejudice concerning native Colorado wood products will be discussed along with means of alleviating these problems. Further, economic incentives which might be necessary will be examined as they relate to a control program.

Case Study Analysis

Each of the six processing centers was analyzed on a case study basis, and the following information is available for each within the case summaries.

- 1) products currently produced
- 2) estimated mill overrun for each product
- 3) mill residues (chips, sawdust, shavings) from each product
- 4) stumpage costs, procurement costs, milling costs, transportation costs and product values for each product in each marketing zone
- 5) economic residuals for each product in each marketing zone
- 6) location of the five marketing zones
- 7) where these products were currently and can be potentially sold
- 8) location of the timber procurement area
- 9) acres of forested and accessible commercial forest land in each procurement area
- 10) allowable cuts, current cuts, and recommended cuts for spruce-fir, lodgepole pine, and ponderosa pine raw material
- 11) maximum product production capacity and the current annual product production for each product

Summary for the Entire Area of Concern

Housing and Population Trends and Firewood Consumption

Primary market conditions and trends are frequently derived from activity in the building trades. Building permits and housing starts

reflect the demand for structural wood products. Overall, the demand for wood products is based on requirements for many end products including housing, furnishings, and paper products. This demand itself is based on requirements for goods, ability to purchase, and our numbers.

The U.S. Forest Service in a Report of the President's Advisory Panel on Timber and the Environment, (PAPTE) 1973, projects the following levels of wood demand-influencing factors:

	<u>Projected 1980 Level</u>		<u>1976 Level</u>
	(medium)	(high)	
GNP-annual real increase %	4.0	4.5	
Population (millions)	228	232	215
Housing units, av. annual level (millions)	2.31	2.43	1.8

These factors will affect the stability of present market conditions, volume, and pricing. U.S. population statistics stood at 207 million in 1971, and even considering slower population growth, promises to attain approximately 230 million by 1980. Household formation, based on numbers of young persons married and single, has shown a marked trend toward single family dwellings. Assuming average incomes remain relatively high, the number of households in the 1970's and 1980's will exceed 1960 level formation by 20 to 30 percent. (PAPTE, 1973)

In 1975, non-residential construction activity slowed to an annual production level of just under a billion square feet. In 1976, non-residential construction, though just equaling the 1975 level, showed a steady improvement throughout the year. On a regional basis, in 1976 the Midwest and South carried the growth in the non-residential market for the nation over 1975. The strongest region was the Midwest with approximately a 13% gain over the 1975 level. The West and Northeast fell within 5 to 10% of value of building the previous year. (Architectural Record, February 1977)

Residential construction fared well due to the housing scarcity and available mortgage money. This resulted in gains for every region of the country, including a 50% gain in the West.

In Colorado, building permits in the immediate marketing area of the processing centers along the Front Range have shown a substantial decline from 1972 to 1975. They have decreased from a high of 477,000 permits in 1972 to 226,000 permits in 1975. However, a leveling off of the marginal difference occurred in the latter years (see Table 4). These figures, to a degree, paralleled privately owned housing starts on a national level for those same years.

The Midwest noted greater gains in non-residential building than any other region, and was second to the West in residential housing. Thus, in the total marketing area, demand for wood products would seem to be increasing at a greater rate than the U.S. as a whole.

Another factor that would seem to indicate an increase in consumption of Front Range wood products is the increase in population in the marketing area. Inherent in general economic growth is the assumption that overall consumer demand will increase with population growth. In our study marketing area, encompassing all or parts of 16 states, the population grew at a 16% rate from 43,500,000 in 1960 to a 1970 total of 51,600,000 compared to a 11% national growth rate. One would anticipate an emerging demand for wood products in the market area over the national level potentials (see Table 4).

The demand for firewood along the Front Range may also be examined as a result of population increases. Based on a U.S.F.S. 1967 fuelwood marketing study in Colorado, the number of wood-burning fireplaces in the four county Denver metropolitan area totaled 56,000 based on an area population of 1,012,000 people. Assuming this proportion is constant, the 27% increase in the metro population by 1976 yields a new total of 71,000 fireplaces. The remainder of the Front Range population, if treated in like manner, indicates the presence of over 36,000 fireplaces, for a Front Range total of over 100,000 fireplaces. If firewood usage is estimated at 0.8 cords annually for an assumed 95% active fuelwood usage market, the annual firewood consumption could approach 76,000 cords. Current level of firewood cut by processors according to this study reaches 3,600 cords leaving user acquisition to account for the remainder of the projection.

Table 4 - Marketing Area Building Permits and Population Data

State / Market Area	Building Permits				Population	
	1972	1973	1974	1975	1960	1970
S. E. Wyoming	1,322	1,101	952	1,325	171,501	170,718
E. Colorado	62,163	41,154	18,161	13,825	1,534,385	1,928,183
N. E. New Mexico	10,394	5,486	3,550	3,384	485,846	553,199
Kansas	16,252	13,285	9,713	12,106	2,178,611	2,247,000
N. Texas	1,537	1,780	1,715	2,143	356,522	336,921
Oklahoma	26,368	14,490	7,188	7,213	2,009,744	1,974,053
Nebraska	13,525	10,184	6,981	7,897	1,393,330	1,466,515
Missouri	34,483	25,014	14,659	15,680	4,659,920	4,402,356
Iowa	13,956	11,650	11,501	14,706	2,757,537	2,824,336
S. South Dakota	1,749	1,597	1,050	1,359	307,183	308,266
S. Minnesota	29,014	15,859	14,026	11,935	1,983,437	2,307,722
Illinois	79,370	66,309	36,886	39,325	10,081,158	11,113,916
Indiana	40,161	39,974	23,937	23,096	4,662,495	5,193,669
Michigan	61,696	56,834	33,713	26,904	6,889,916	7,501,985
Wisconsin	36,310	34,179	26,023	26,002	3,951,777	4,447,321
W. Ohio	49,091	33,187	21,646	19,672	4,334,426	4,865,218
TOTALS	477,386	372,089	231,601	226,522	43,503,463	51,621,378

Reference; Bureau of the Census, Construction Reports, 1972-75, U.S. Dept. of Commerce.

The amount of firewood consumption is just an estimate of the current wood-using domestic activity along the Front Range. Ideally, for the purposes of this study, market demand information is needed in each marketing area zone for each processing center. However, this type of information is simply unavailable, even for firewood.

An estimate, however, of market demand for each product at each processing center can be made by making two assumptions. First, one can assume that the market consumption of a product equals its current production. Second, one can assume that the demand for a product is the same in all marketing area zones where it is currently economically feasible to market it. Given the size of the market area, in many cases market consumptions could be much higher than what the producers are currently producing, or capable of producing with present equipment.

Despite the weaknesses of these assumptions, this was the only expeditious means available to give some estimate of the market demand for certain products. These demand assumptions are important factors in developing alternative production and marketing strategies for each processing center.

1 1 1 1

[illegible]

Table 5 --Sample Goal Programming Matrix (cont)

	MARKETING AREAS 0-5 MILES									RHS
	boards-selp x10	boards-PP x11	boards PPd<5 x12	chips x13	sawdust x14	shavings x15	fence pl-SPLP x16	fence p.-PP x17	fence p-PPd<5 x18	
Raw Material Supply (annual cut)										< MCF
SF-LP sawtimber	-1						-1			< MCF
poletimber										< MCF
PP sawtimber		-1						-1		< MCF
poletimber										< MCF
PP (dead<5 yrs) sawtimber			-1						-1	< MCF
poletimber										
Mill Residues										
chips										=0
sawdust										=0
shavings										=0
Product Capacity or current annual production										
boards(r)										<MCF
fence posts										<MCF
Linkage to Markets										
boards(r)SFLP -1										=0
boards(r)PP		-1								=0
boards(r)PPd 5			-1							=0
fence p. SFLP							-1			=0
fence P. PP								-1		=0
fence p.PPd 5									-1	=0
chips				-1						=0
sawdust					-1					=0
shavings						-1				=0
Residual										
(MR-MC-P&R)	161	107	88	27	29	29	1264	1252	1245	<\$999,999

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Case Study I--FORT COLLINS - LOVELAND CASE STUDY

The Fort Collins - Loveland case study has a timber procurement base of over 1 million acres. This procurement acreage was developed in C.S.U. Project #2192. As detailed earlier in this report the procurement zone encompasses areas of present or potential supply for area mills. To avoid the complexity of overlapping procurement areas between processing centers, the center holding a competitive advantage was considered to be the sole timber buying center. The Fort Collins - Loveland procurement area encompasses private and state land including the Colorado State Forest as well as parts of Roosevelt and Routt National Forests (see Figure I-1). Figure I-2 illustrates as a percentage, the ownership portions composing the procurement area as well as accessible acreage within those areas. Table I-1 lists acreage totals for each ownership.

The timber supply in terms of annual allowable cut, current cut and recommended annual cut were obtained from C.S.U. Project #2192. The raw material supply as displayed in Table I-2 illustrates these cut determinations. It is important to notice different levels of cut for ponderosa pine under varying determinations.

As given on page 15, each case study has four alternative configurations. These configurations or alternative value sets were designed to represent four different overriding goals. As the structure for each alternative is given, they will not be discussed here but, their input factor values will be displayed as each alternative is discussed. The constraints would represent types and levels of

timber cut per species and mill capacities for various products with a standard profit per product used for all subsequent alternatives.

Figure I-1 - Fort Collins-Loveland Tributary Area

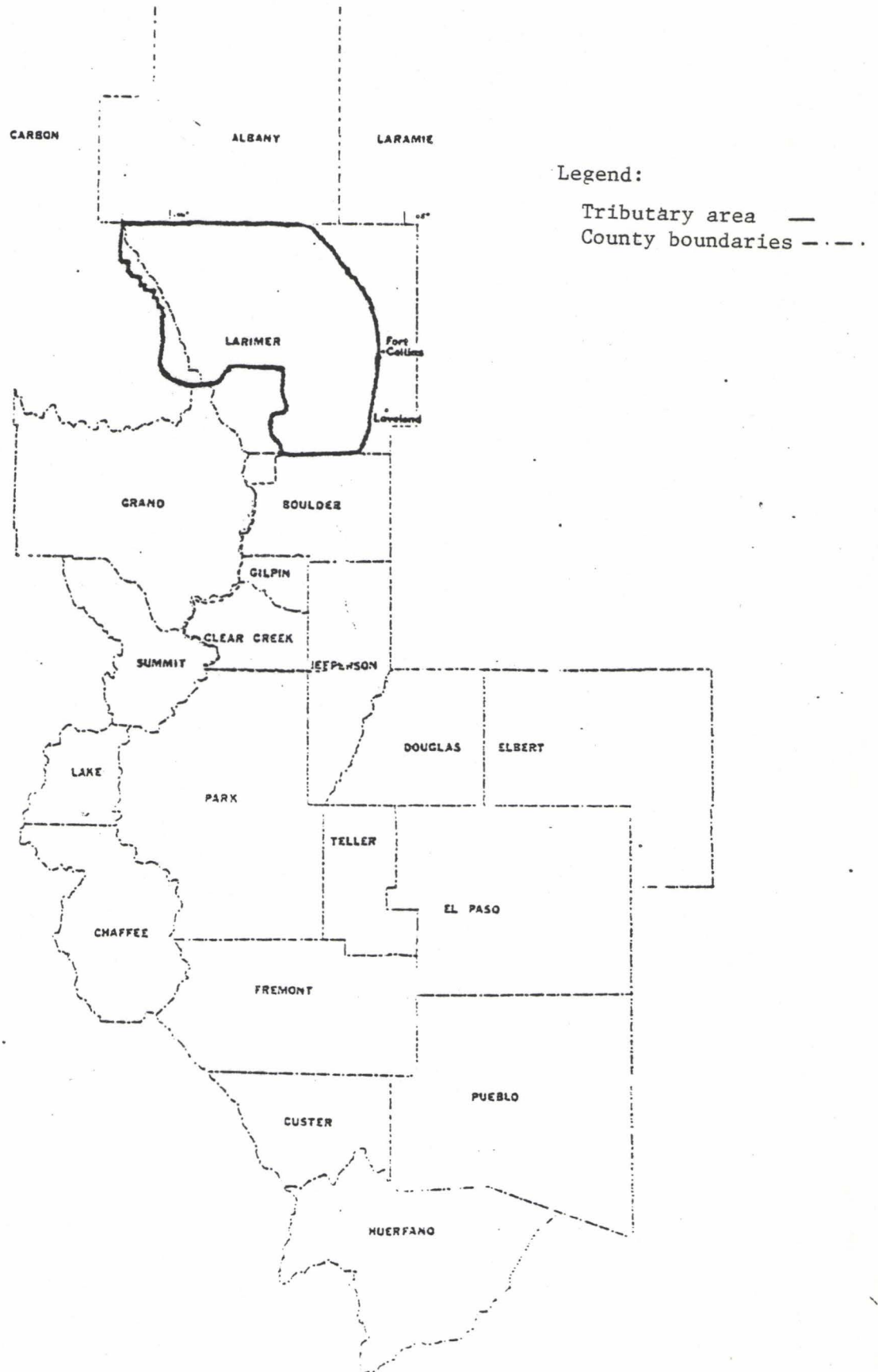
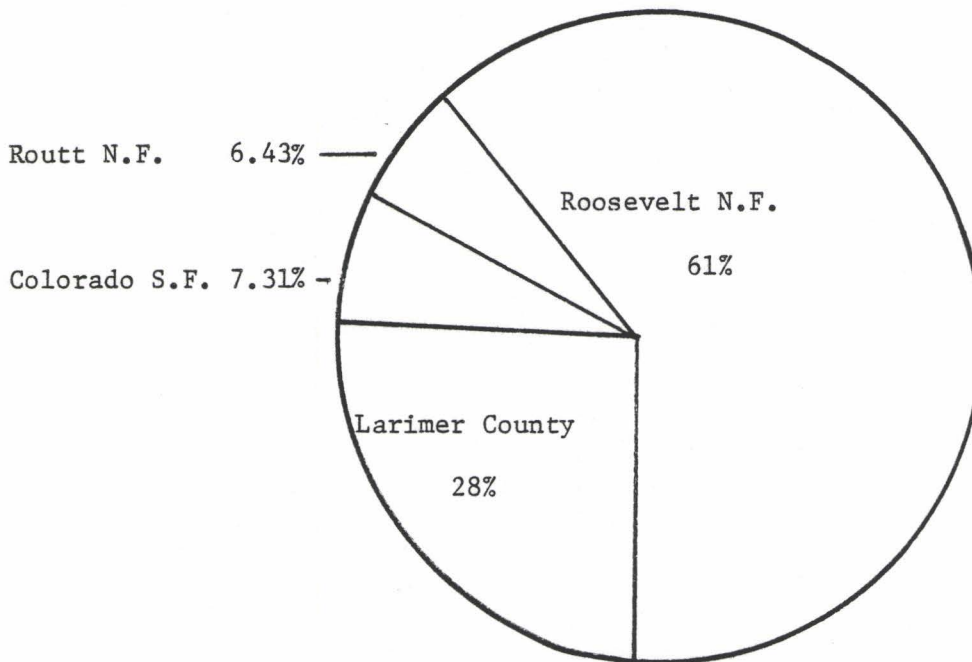


Figure I-2- Fort Collins-Loveland
Timber Procurement Area

Total Procurement Area



Accessible Commercial Area

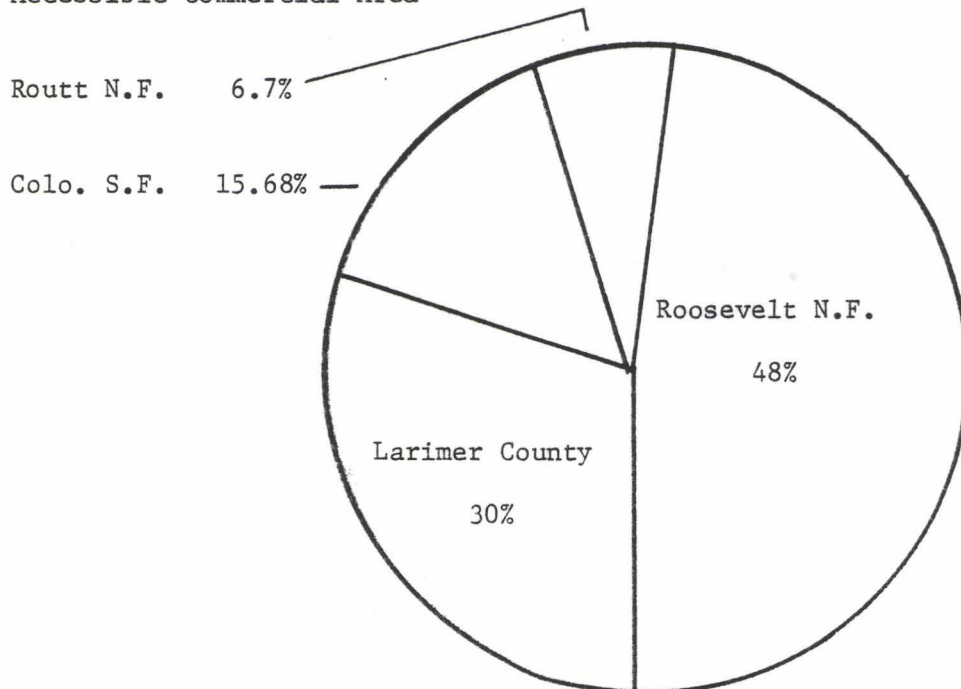


TABLE I-1 - Fort Collins-Loveland
Timber Procurement Area^{1/}

PROCUREMENT AREA:

Roosevelt National Forest:	615,369	acres
Routt National Forest :	65,250	
Colorado State Forest :	74,250	
Larimer County (state & private):	<u>259,900</u>	
Total:	1,014,769	acres

(forested acres, at least 10% stocked)

ACCESSIBLE COMMERCIAL FOREST LANDS - PROCUREMENT AREA:^{1/}

Roosevelt National Forest:	153,104	acres
Routt National Forest :	21,330	
Colorado State Forest :	47,900	
Larimer County:	<u>95,300</u>	
Total:	317,634	acres

^{1/} Standard and special component areas on national forest land, all state and private lands.

TABLE I-2 - Fort Collins-Loveland
Raw Material Supply

Allowable Cut

<u>Species</u>	<u>Size class</u>	<u>bdft/cuft</u>	<u>allowable</u>	<u>bdft/cuft</u>	<u>product</u>
ponderosa pine	sawtimber	5 / 1	1,441 MCF	10 / 1	720 MCF
ponderosa pine	poletimber	5 / 1	820	5 / 1	820
spruce-fir	sawtimber	5 / 1	1,441	10 / 1	720
spruce-fir	poletimber	5 / 1	820	5 / 1	820
lodgepole pine	sawtimber	5 / 1	2,882	10 / 1	1,441
lodgepole pine	poletimber	5 / 1	1,640	5 / 1	1,640

Current Cut

<u>Species</u>	<u>Size class</u>	<u>bdft/cuft</u>	<u>current</u>	<u>bdft/cuft</u>	<u>product</u>
ponderosa pine	sawtimber	5 / 1	661 MCF	10 / 1	330 MCF
ponderosa pine	poletimber	5 / 1	165	5 / 1	165
spruce-fir	sawtimber	5 / 1	661	10 / 1	330
spruce-fir	poletimber	5 / 1	165	5 / 1	165
lodgepole pine	sawtimber	5 / 1	1,322	10 / 1	661
lodgepole pine	poletimber	5 / 1	330	5 / 1	330

Recommended Cut

<u>Species</u>	<u>Size class</u>	<u>bdft/cuft</u>	<u>recommend</u>	<u>bdft/cuft</u>	<u>product</u>
ponderosa pine	sawtimber	5 / 1	2,359 MCF	10 / 1	1,179 MCF
ponderosa pine	poletimber	5 / 1	245	5 / 1	245
ponderosa pine (dead < 5 years)		5 / 1	1,564	8 / 1	962
ponderosa pine (salable dead > 5 yrs)		5 / 1	214	5 / 1	214

Productive capability in the Fort Collins - Loveland processing center was estimated from personal discussions with mills in the locale, U.S.F.S. appraisals and telephone discussions (See Table I-15). The productive capability figures assume a 240 day operational year, 8 hours per day. Production capability is shown in Table I-3 with Table I-4 displaying current annual production for area mills. A definition of the products produced in the Fort Collins - Loveland center and their respective conversion factors is shown in Table I-5. This table displays the products standard finished size, the amount of wood per product, and in appropriate cases, a conversion from cubic feet of product to board feet.

TABLE I-3 - Fort Collins-Loveland
Maximum Mill Production Capacity 1/

<u>Product</u>	<u>Output Capacity</u>	<u>Output Capacity</u>
Pallets	215.1 MCF (of products)	430.2 MCF (of roundwood)
Timbers	52.7	105.4
Fencing	201.4	402.8
Rough boards	443.8	887.6
Planed boards	624.8	1,249.6
Houselogs	147.3	147.3
Barn poles	195.7	195.7
Corral poles	330.9	330.9
Fence posts	332.6	332.6
Paneling	77.4	125.8
Dimension	27.4	54.8
Studs	70.8	141.6
Firewood ^{2/}	214.2	348.2
Railroad ties	19.5	39.0
Chips	1,114.6	
Sawdust	554.3	
Shavings	369.3	

1/ (based on an 8 hour day, 240 days/year)

2/ conversion based on present general usage of 45 years raw material for firewood which is based on 1.625 conversion factor

TABLE I-4 - Fort Collins-Loveland
Current Annual Product Production

<u>Product</u>	<u>Output</u>	<u>Output</u>
Pallets	92.9 MCF (of product)	185.8 MCF (of roundwood)
Timbers	39.9	79.8
Fencing	116.5	233.0
Rough Boards	156.4	312.8
Planed Boards	312.4	624.8
Houselogs	100.4	100.4
Barn poles	116.6	116.6
Corral poles	197.3	197.3
Fence posts	198.3	198.3
Paneling	30.5	48.8
Dimension	15.6	31.2
Studs	35.4	70.8
Firewood	53.5	85.6
Railroad ties	0.0	0.0
Chips	511.0	
Sawdust	249.5	
Shavings	212.9	

TABLE I-5 - Fort Collins-Loveland

Product Definition and Conversion Factors

Pallets	4'x4'	20 bdft/pallet	81.47 cuft/MBF
Timbers	6"x6"x8'	treated	81.47
Fencing	3"x1"x6'	0.16 cuft/piece	81.47
Rough Boards	1"x4"		81.47
Planed Boards	1"x4"		54.69
Houselogs	8"x16'	5.58 cuft/log	1 cuft/4 bdft
Barn poles	6"x20'	3.92 cuft/pole	1 cuft/3 bdft
Corral poles	3"x16'	0.78 cuft/pole	1 cuft/3 bdft
Fence posts	3.5"x6.5'	0.43 cuft/post	1 cuft/3 bdft
Paneling	1"x4" ponderosa pine blue stain		54.69 cuft/ MBF
Dimension lumber	3"x4"		81.47
Studs	2"x4"		54.69
Firewood	4'x4'x8'	85 cuft/cord	
Railroad ties	6"x4"x6'	1 cuft/tie	
Chips	43 cuft/MBF,	25 lbs/cuft	
Sawdust	21 cuft/MBF		
Shavings	16 cuft/MBF		

FORT COLLINS - LOVELAND ALTERNATIVES

The results of implementing each alternative are individually briefed in the following tables. (see Tables I-6, 7, 8, 9) The tables show the constraints and goals for each goal program run. Raw material supply as well as product capacity, reflective of the above constraints, are also shown. It should be noted that the raw material supply for alternatives 1, 2, and 3 are identical for the spruce-fir and lodgepole pine species reflecting like annual cuts. The Ponderosa pine supply classes vary in response to different types of cuts as listed in the constraints. Alternative 4 depicts the current supply and capacity figure inputs which assume present day production activity figures.

TABLE I-6 - Fort Collins-Loveland

Alternative #1 Description

Constraints: -annual allowable cut on spruce-fir and lodgepole pine
 -recommended ponderosa pine cuts
 -annual cut on mortality ponderosa pine and salable dead
 -product capacity for each product

Goals: #1-minimize underachievement of recommended ponderosa pine cuts
 #2-maximization of returns to stumpage

Raw Material Supply (MCF of roundwood):

Resources Used (MCF of roundwood):

SF-Lp	sawtimber	4322.0	1025.0
SF-Lp	poletimber	2460.0	761.5
PP	sawtimber	2358.0	2358.0
PP	poletimber	245.0	245.0
PP	dead < 5 years	1564.0	474.1
PP	dead > 5 years	214.0	0.0
	TOTAL	11,163.0	4,863.6

Maximum Mill Production Capacity (MCF of roundwood):

pallets	430.2
timbers	105.4
fencing	402.8
rough boards	887.6
planed boards	1249.6
houselogs	147.3
barn poles	195.7
corral poles	330.9
fence poles	332.6
paneling	125.8
dimension lumber	54.8
studs	141.6
firewood	348.2
railroad ties	39.0

SF-Lp = spruce-fir, lodgepole pine

PP = ponderosa pine

TABLE I-7 - Fort Collins-Loveland
Alternative #2 Description

Constraints: - annual allowable cut on spruce-fir, lodgepole pine
 and ponderosa pine
 - recommended annual cuts on mortality and salable
 dead

Goals: #1-minimize underachievement of removing previous
 year ponderosa pine mortality
 #2-maximize returns to stumpage

Raw Material Supply (in MCF of roundwood):		Resources Used (MCF of roundwood):	
SF-Lp	sawtimber	4,322.0	2,333.6
SF-Lp	poletimber	2,460.0	610.6
PP	sawtimber	1,440.0	0.0
PP	poletimber	820.0	0.0
PP	dead<5 yrs.	1,564.0	1,564.0
PP	dead>5 yrs.	214.0	214.0
TOTAL		10,820.0	4,722.2

Maximum Mill Production Capacity (MCF of roundwood):

pallets	430.2
timbers	105.4
fencing	402.8
rough borads	887.6
planed boards	1,249.6
houselogs	147.3
barn poles	195.7
corral poles	330.9
fence poles	332.6
paneling	125.8
dimension lumber	54.8
studs	141.6
firewood	348.2
railroad ties	9.0

TABLE I-8 - Fort Collins-Loveland

Alternative #3 Description

Constraints: -annual allowable cuts on spruce-fir, lodgepole, and ponderosa pine
 -recommended annual cut on mortality ponderosa pine and salable
 dead

Goals: #1-maximization of returns to stumpage

Raw Material Supply (MCF of roundwood):		Resources Used (MCF of roundwood):	
SF-Lp	sawtimber	4322.0	3232.7
SF-Lp	poletimber	2460.0	1006.5
PP	sawtimber	1440.0	0.0
PP	poletimber	820.0	0.0
PP	dead < 5 years	1564.0	474.1
PP	dead > 5 years	214.0	0.0
TOTAL		10,820.0	4,713.3

Maximum Mill Production Capacity (MCF of roundwood):

pallets	430.2
timbers	105.4
fencing	402.8
rough boards	887.6
planed boards	1249.6
houselogs	147.3
barn poles	195.7
corral poles	330.9
fence poles	332.6
paneling	125.8
dimension lumber	54.8
studs	141.6
firewood	348.2
railroad ties	39.0

TABLE I-9 - Fort Collins-Loveland

Alternative #4 Description

Constraints: -current cut level for lodgepole pine, spruce-fir, and ponderosa pine
 -recommended annual cut for mortality pine
 -current annual production levels for each product

Goals: #1-maximization of returns to stumpage

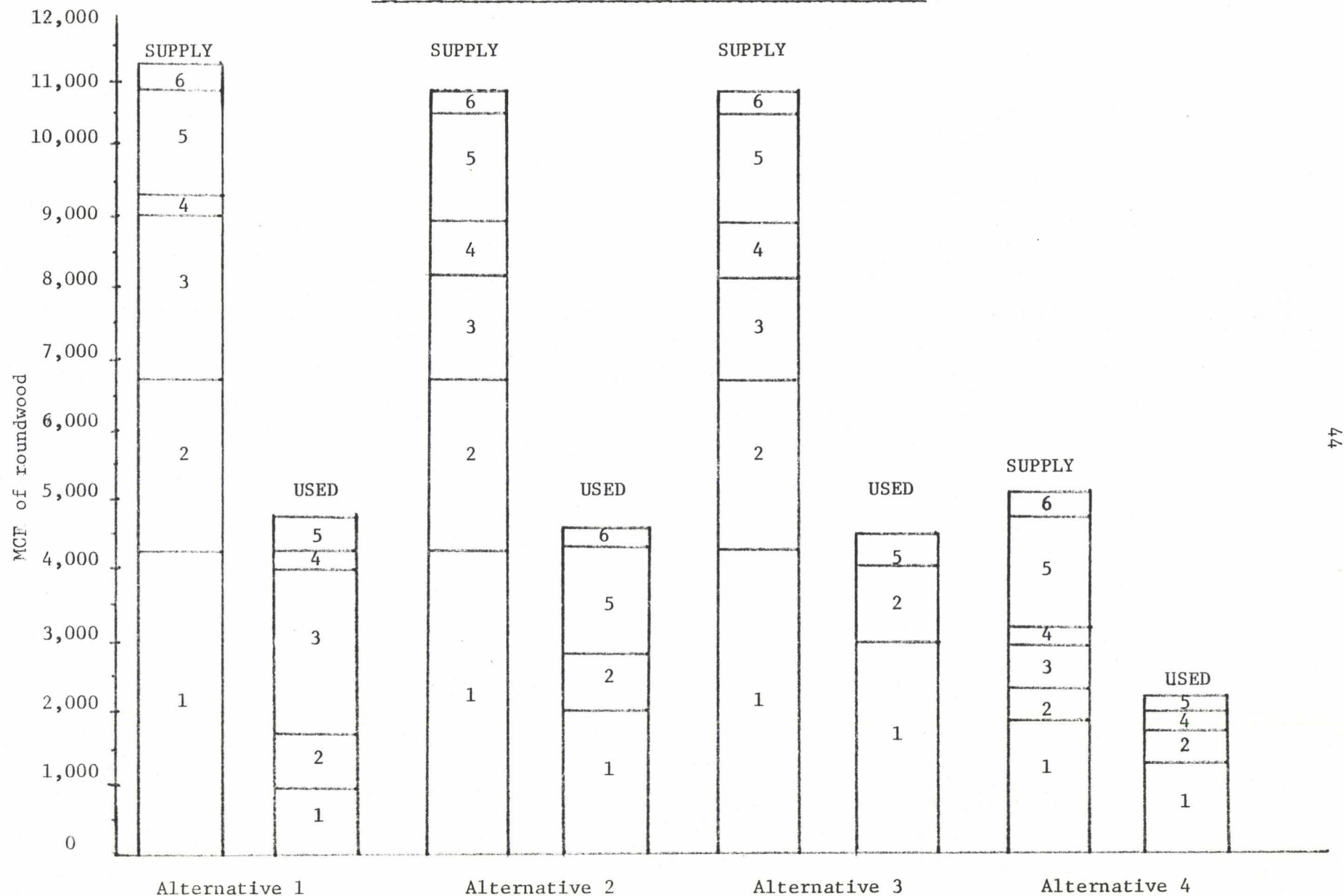
Raw Material Supply (MCF of roundwood):		Resources Used (MCF of roundwood):
SF-Lp	sawtimber	1982.0
SF-Lp	poletimber	495.0
PP	sawtimber	660.0
PP	poletimber	165.0
PP	dead < 5 years	1564.0
PP	dead > 5 years	214.0
TOTAL		5,080.0
		1478.9
		495.0
		0.0
		117.6
		136.6
		0.0
		2,228.1

Current Mill Production (MCF of roundwood):

pallets	185.8
timbers	79.8
fencing	233.0
rough boards	312.8
planed boards	624.8
housetlogs	100.4
barn poles	116.6
corral poles	197.3
fence poles	198.3
paneling	49.6
dimension lumber	31.2
studs	70.8
firewood	87.0
railroad ties	0.0

TABLE I-10 - Fort Collins-Loveland

RAW MATERIAL SUPPLY versus RAW MATERIAL CONSUMED



1 = spruce-fir, lodgepole sawtimber
2 = spruce-fir, lodgepole poletimber

3 = ponderosa pine sawtimber
4 = ponderosa pine poletimber

5 = ponderosa, dead < 5 yrs.
6 = ponderosa, dead > 5 yrs.

The resources used in each alternative from its raw material supply is also given on the alternative description tables. Resources used from different material classes are also displayed adjacent raw material available, in Table I-10. This shows, for each alternative, percentages as a portion of total supply, and percentages as a portion of total used, the relative levels of all materials classes. Thus by examining the output strictly in terms of supply the observer may determine the impact of a certain alternative strategy on the consumption of a certain size and species class of timber relative to the others.

The total amount of each material class in each case alternative used is broken down into ultimate products in Table I-11. Thus the amount of a given material class, for example, ponderosa pine used for the production of pallets in Alternative 1, was 430.20 MCF. In comparing this amount with the total capacity for pallets in Fort Collins Table I-6, it is determined that the pallet capacity for this processing center is exhausted. Referring back to the market consumption table, it is apparent that this total capacity was produced and sold locally. Figure I-3 depicts the Fort Collins-Loveland marketing area and Figure I-4 displays transportation isocost lines relative to products shipped from the processing center. Referring to Table I-14, the return to stumpage obtained from selling ponderosa pine pallets is \$521/MCF of product or \$260/MCF of roundwood. This compares with pallets from lodgepole pine and spruce-fir where the return would have been higher per MCF and, dead < 5 years wood which would be lower. Remembering the overriding goal in alternative 1 - to minimize underachievement

Figure I-3 - Marketing Area for Fort Collins-Loveland Processing Center

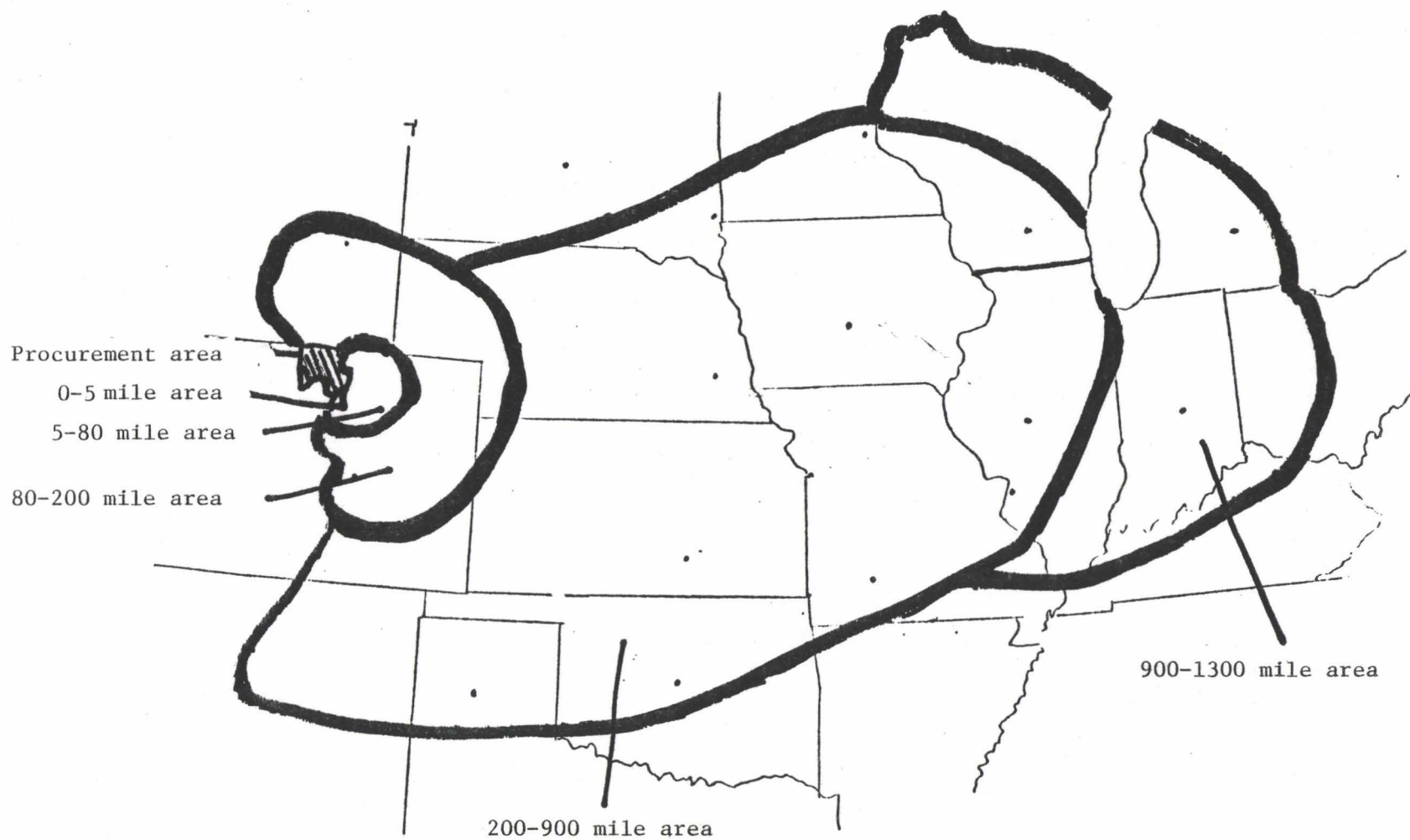
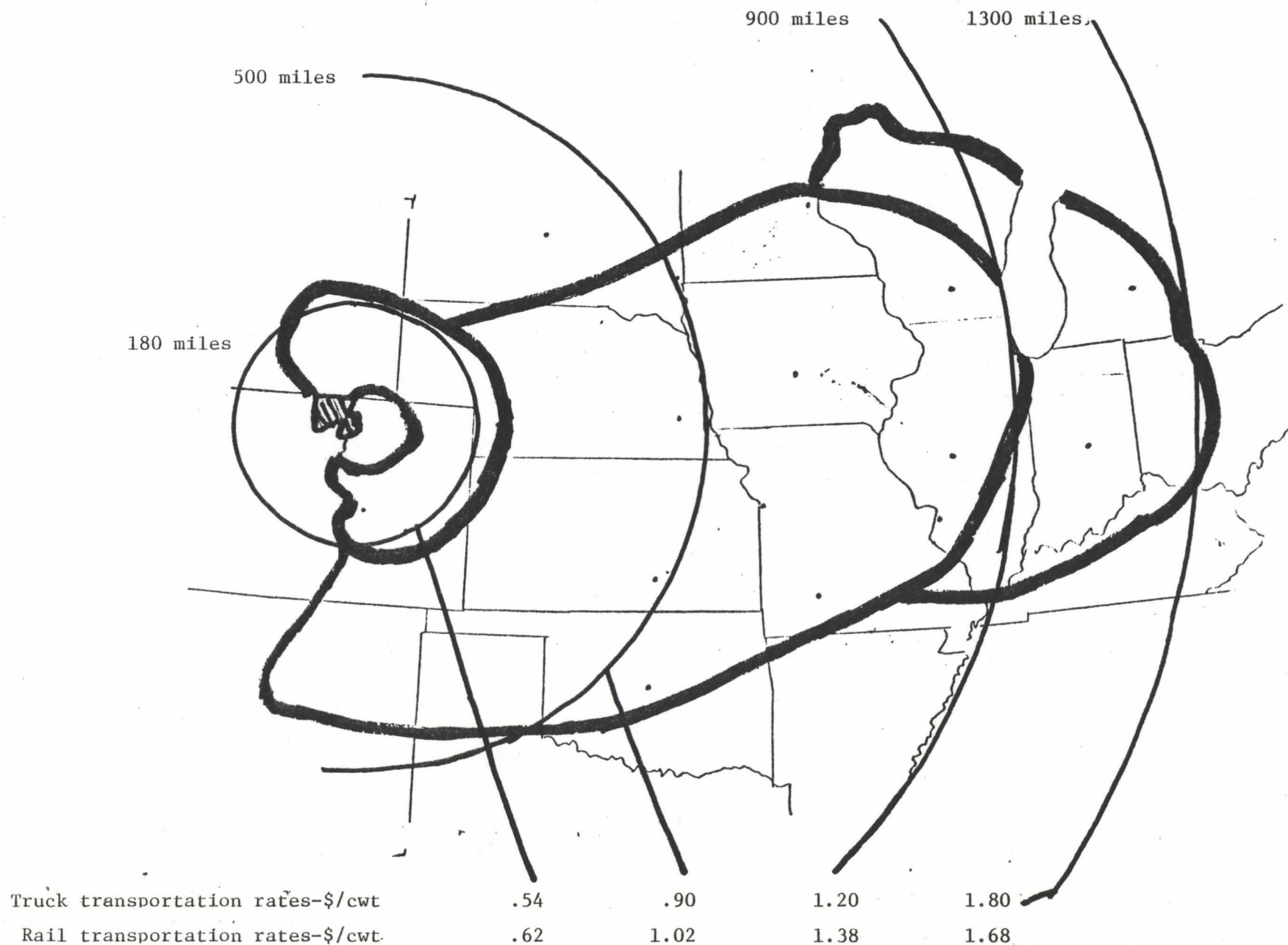


Figure I-4 - Transportation Isocost Map and Marketing Area for Fort Collins-Loveland



of recommended ponderosa pine cuts and to maximize returns to stumpage, this allocation meets both criteria. If the pallets had been marketed in a more distant zone, the value per MCF would have declined.

The total return due to the consumption of raw materials in terms of products is illustrated in Table I-12. The table sums values for given numbers of products sold in a market area by raw material class. The material classes here are grouped into ponderosa pine, live which includes sawtimber and poletimber, ponderosa pine dead which includes dead<5 years, dead>5 years and spruce-fir and Lodgepole materials grouped together. Thus in alternative #1, the 5 - 80 mile market area depicts a total return of \$285,970 of which \$224,000 plus was realized from spruce-fir and lodgepole with the remainder in chips, shavings, and sawdust. Ponderosa pine raw material contributes nothing to the total return, indicating a lack of ponderosa pine products in the 5 - 80 mile zone in Table I-11, the market consumption table.

Table I-13, returns to stumpage, shows the total profit distribution in each alternative by material class, enabling the observer to quickly note what amount, for example, of a total return is due to dead and beetle-killed ponderosa pine.

The returns per MCF of a given product are illustrated in Table I-14, Mills Marginal Revenue. This table lists the marginal revenue, marginal cost, profit and risk, and residual or return for each product. The products are listed by raw material type and marketing area to allow recognition of changes in return/MCF of product from one marketing area to the next. This table also is keyed to display products currently marketed but uneconomical, economical

but not presently marketed, and products neither presently economical or marketed. These figures are derived from the cost breakdown sheet, Table I-15. These two tables served as inputs to the goal program involved in determining which products could maximize returns in each marketing area and for the case study as a whole.

TABLE I-11 - Fort Collins-Loveland

MARKET CONSUMPTION: RESOURCES TO PRODUCTS (IN MCF OF ROUNDWOOD) - NO MARKET DEMAND RESTRICTIONS

ALT. 1			ALT. 2		ALT. 3		ALT. 4	
0-5 mile	pallets (PP)	430.2	pallets (D<5)	349.7	pallets (SL)	430.2	pallets (SL)	185.8
	fencing (PP)	402.8	fencing (D<5)	327.4	fencing (SL)	402.8	fencing (SL)	233.0
	boards r (SL)	887.6	boards r (SL)	887.6	boards r (SL)	887.6	boards r (SL)	312.8
	boards p (PP)	1249.6						
	dimension (SL)	54.8	dimension (SL)	54.8	dimension (SL)	54.8	dimension (SL)	31.2
	studs (PP)	131.0						
	studs (SL)	10.6	studs (SL)	141.6	studs (SL)	141.6	studs (SL)	70.8
	firewood (D<5)	348.2	firewood (D>5)	348.2	firewood (D<5)	348.2	firewood (D<5)	87.0
5-80 mile	houselogs (SL)	147.3	houselogs (SL)	147.3	houselogs (SL)	147.3	houselogs (SL)	100.4
	barn pole (SL)	195.7	barn p (D<5) barn p (SL)	63.3 132.4	barn pole (SL)	195.7	barn p (SL) corral p (PP) corral p (SL)	116.6 117.6 79.7
	corral p (SL)	330.9	corral p (SL)	330.9	corral p (SL)	330.9	chips	422.2
	chips	914.9	chips	914.9	chips	914.9	sawdust	195.2
	sawdust	445.4	sawdust	445.4	sawdust	431.8	shavings	213.2
	shavings	395.8	shavings	395.8	shavings	395.8		
	timbers (PP)	105.4	timbers (D<5)	85.7	timbers (SL)	105.4	timbers (SL)	79.8
	fence p (PP)	245.0	fence p (D<5)	332.6	fence p (SL)	332.6	fence p (SL)	198.3
80-200 mile	fence p (SL)	87.6						
	RR ties (PP)	39.0	RR ties (D<5)	12.0	RR ties (SL)	39.0		
200-900 mile	paneling (D<5)	125.8	paneling (D<5) boards p (SL)	125.8 1249.6	paneling (D<5) boards p (SL)	125.8 1249.6	paneling (D<5) boards p (SL)	49.6 624.8

PP=ponderosa pine SL=spruce-fir, lodgepole
p = planed; poles or posts r = rough

D<5=ponderosa, dead<5 yrs. D>5=ponderosa, dead>5 yrs.

TABLE I-12 - Fort Collins-Loveland

TOTAL RETURNS DISTRIBUTION PER MARKET ZONE AND ALTERNATIVE

		0-5 mile area	5-80 mile area	80-200 mile area	200-900 mile area
Alternative 1	total returns	\$575,446.70	\$285,970.00*	\$623,139.50	\$164,010.60
	due to PP live	490,632.10	0.00	491,476.70	0.00
	due to PP dead	5,569.20	0.00	0.00	164,010.60
	due to SF-LP	79,245.40	224,503.00	131,662.80	0.00
2	total returns	\$294,394.40	\$280,526.20*	\$558,347.50	\$708,211.40
	due to PP live	0.00	0.00	0.00	0.00
	due to PP dead	189,604.00	25,193.40	558,347.50	164,010.60
	due to SF-LP	104,790.40	193,865.80	0.00	544,200.80
3	total returns	\$326,777.90	\$285,492.25*	\$629,400.70	\$708,211.40
	due to PP live	0.00	0.00	0.00	0.00
	due to PP dead	5,569.20	0.00	0.00	164,010.60
	due to SF-LP	321,208.70	224,503.00	629,400.70	544,200.80
4	total returns	\$150,950.60	\$165,400.35*	\$380,119.20	\$336,729.90
	due to PP live	0.00	28,767.60	0.00	0.00
	due to PP dead	1,391.00	0.00	0.00	64,629.50
	due to SF-LP	149,559.60	107,560.00	380,119.20	272,100.40

* Chips, sawdust, shavings are included in this value.

Returns here are defined as the residual. That is the price less all costs plus a margin for profit and risk.

TABLE I-13 - Fort Collins-Loveland

Returns to Stumpage (Revenue as residual)

	Revenue due to live PP	Revenue due to dead PP	Revenue due to SF-LP	Revenue due to residue	Total revenue
Alternative #1	\$982,108.80	169,579.80	435,411.20	61,467.00	1,648,463.00
Alternative #2	\$ 0.0	939,934.90	842,857.00	61,467.00	1,841,473.24
Alternative #3	\$ 0.0	169,579.80	1,719,313.20	60,989.25	1,949,832.00
Alternative #4	\$ 28,694.40	66,020.50	909,339.20	29,072.75	1,033,126.79

TABLE I-14 - Mills Marginal Revenues, Marginal Costs, Profits + Risk,
and Residual

$$MR - MC - P + P = R^*$$

MR (Wholesale Price)

MC (Stumpage Costs + Procurement Costs + Milling Costs + Transportation
to Market Costs)

P + R (10% of MC for Profit + Risk)

R (Residual) in terms of \$ MCF of product

* (When R is less than 0 the product is considered uneconomical to market in
the marketing area)

Key

- 1) If there is no symbol in front of the product, it is currently marketed and is considered economical.
- 2) * means the product is currently marketed and is considered uneconomical. using the R value as a basis for defining if its economical.
- 3) **means the product is not currently marketed, but is considered economical to market.
- 4) ***means the product is not currently marketed, and is considered uneconomical.

- (PP) ponderosa pine

- (LP) lodgepole pine

- (SF) spruce-fir

- (D<5yr) ponderosa pine that has been dead for five years or less.

- Chips (D) = chips from dead wood

- Chips (G) = chips from green wood

TABLE I-140-5 Mile Marketing Area Zone

<u>Products</u>	<u>MR/ (MCF)</u>	<u>MC/ (MCF)</u>	<u>P+R/ (MCF)</u>	<u>Residual/ (MCF)</u>
Barn Poles (PP)	3360	2758	276	326
Barn Poles (LP)	3360	2716	272	372
Barn Poles (SF)	3360	2716	272	372
Barn Poles (D<5yr)	3360	2794	279	287
Houselogs (PP)	1860	1491	149	220
Houselogs (LP)	1860	1449	145	266
Houselogs (SF)	1860	1449	145	266
Houselogs (D<5yr)	1860	1527	153	180
Corral P (PP)	2880	2606	261	13
Corral P (LP) & (SF)	2880	2595	259	26
Corral P (D<5yr)	2880	2612	261	7
Fence P (PP)	3372	2476	248	648
Fence P (LP) & (SF)	3372	2465	247	660
Fence P (D<5yr)	3372	2482	248	642
Boards R (PP)	1800	1532	153	107
Boards R (LP) & (SF)	1800	1490	149	161
Boards R (D<5)	1800	1556	156	38
Boards P (PP)	3657	2928	293	436
Boards P (LP) & (SF)	3840	2864	286	690
Boards P (D<5)	3474	2964	296	214
Studs (PP)	3291	2701	270	320
Studs (LP) & (SF)	3291	2637	264	390
Studs (D<5)	3200	2767	277	156
Paneling (D<5)	5485	4390	439	656
Pallets (PP)	3000	2254	225	521
Pallets (LP) & (SF)	3000	2212	221	567
Pallets (D<5yr)	3000	2278	228	494

<u>Products</u>	<u>MR</u>	<u>MC</u>	<u>P+R</u>	<u>Residual</u>
Timbers (PP)	3720	2793	279	648
Timbers (LP) + (SF)	3720	2761	276	683
Timbers (D<5 yr.)	3720	2817	282	621
Fencing (PP)	3240	2561	256	423
Fencing (LP) + (SF)	3240	2519	252	469
Fencing (D<5 yr.)	3240	2582	258	400
Dimension (PP)	2640	2252	225	163
Dimension (LP + SF)	2640	2210	221	209
Dimension (D<5 yr.)	2640	2276	228	136
RR Ties (PP)	3720	2853	285	582
RR Ties (LP) + (SF)	3720	2811	281	628
RR Ties (D<5 yr.)	3720	2877	287	556
Firewood (D<5)	588	511	51	26
Firewood (D>5)	588	523	52	13
Chips (D)	75	42	4	29
Chips (G)	75	42	4	29
Shavings	75	42	4	29
Sawdust	75	42	4	29

5-80 Mile Marketing Area Zone

Barn Poles (PP)	3564	2842	284	438
Barn Poles (LP) + (SF)	3564	2800	280	484
Barn Poles (D<5)	3564	2878	288	398
Houselogs (PP)	2004	1578	158	268
Houselogs (LP) + (SF)	2004	1536	154	306
Houselogs (D<5)	2004	1614	161	229
Corral P (PP)	3204	2691	269	244

<u>Products</u>	<u>MR</u>	<u>MC</u>	<u>P+R</u>	<u>Residual</u>
Corral P (LP) + (SF)	3204	2680	268	256
Corral P (D<5)	3204	2697	270	237
Fence P (PP)	4069	2561	256	1252
Fence P (LP) + (SF)	4069	2550	255	1264
Fence P (D<5)	4069	2567	257	1245
Boards P (PP)	3657	3007	300	350
Boards P (LP) + (SF)	3840	2943	294	603
Boards P (D<5)	3474	3043	304	127
Studs (PP)	3291	2780	278	233
Studs (LP) + (SF)	3291	2706	271	314
Studs (D<5)	3291	2846	285	160
Paneling (D<5)	6948	4449	445	2054
Pallets (PP)	3000	2355	235	410
Pallets (LP) + (SF)	3000	2313	231	456
Pallets (D<5)	3000	2379	238	383
Timbers (PP)	3240	2885	288	67
Timbers (LP +SF)	3240	2843	284	113
Timbers (D<5)	3240	2909	290	41
Fencing (PP)	3240	2647	264	329
Fencing (LP) + (SF)	3240	2605	260	375
Fencing (D<5)	3240	2668	267	305
RR Ties (PP)	3410	2946	295	169
RR Ties (LP) + (SF)	3410	2904	290	216
RR Ties (D<5)	3410	2970	297	143
Chips (D)	187	138	14	35
Chips (G)	187	138	14	35
Shavings	187	138	14	35

<u>Products</u>	<u>MR</u>	<u>MC</u>	<u>P & R</u>	<u>Residual</u>
Sawdust	187	138	14	35
***Dimension L. (All)	-	-	-	-88
***Rough Lumber (All)	-	-	-	-136
***Firewood (All)	-	-	-	-198

80-200 Mile Marketing Area Zone

Barn Poles (PP)	3408	3046	304	58
Barn Poles (LP) + (SF)	3408	3004	300	104
Barn Poles (D<5yr)	3408	3082	308	18
Houselogs (PP)	1944	1767	176	1
Houselogs (LP) + (SF)	1944	1725	172	47
Fence P (PP)	4536	2768	277	1,491
Fence P (LP) + (SF)	4536	2757	276	1,503
Fence P (D<5yr)	4536	2774	277	1,305
Boards P (LP) + (SF)	3474	3030	303	141
**Studs (LP) + (SF)	3108	2803	280	25
Paneling (D<5)	6948	4551	455	1,942
**Pallets (PP)	3000	2618	262	120
**Pallets (LP) + (SF)	3000	2576	258	166
**Pallets (D<5)	3000	2642	264	94
Timbers (PP)	5388	3070	307	2011
Timbers (LP) + (SF)	5388	3028	303	2057
Timbers (D<5yr)	5388	3094	309	1985
Fencing (PP)	3240	2862	286	92
Fencing (LP) + (SF)	3240	2820	282	138
Fencing (D<5yrs)	3240	2883	288	70
Railroad Ties (PP)	4488	3138	314	1036

<u>Products</u>	<u>MR</u>	<u>MC</u>	<u>P + R</u>	<u>Residual</u>
Railroad Ties (LP) + (SF)	4488	3096	310	1082
Railroad Ties (D<5)	4488	3162	316	1010
*Houselogs (D<5)	-	-	-	39
*Corral P (All)	-	-	-	163
***Boards P (PP)	-	-	-	- 112
***Boards P (D<5)	-	-	-	- 243
***Studs (PP)	-	-	-	- 44
***Studs (D<5)	-	-	-	- 175
***Boards R (All)	-	-	-	- (Very High)
***Dimension (All)	-	-	-	- (Very High)
***Firewood (All)	-	-	-	- (Very High)
***Chips (All)	-	-	-	- (Very High)
***Shavings	-	-	-	- (Very High)
***Sawdust	-	-	-	- (Very High)

200-900 Mile Marketing Area Zone

<u>Products</u>	MR (MCF)	MC (MCF)	P + R (MCF)	Residual (MCF)
**Fence P (PP)	4069	3610	361	98
**Fence P (LP) + (SF)	4069	3599	360	110
**Fence P (D≤5yr)	4069	3616	362	91
Boards P (PP)	3657	3261	326	70
Boards P (LP) + (SF)	4388	3197	320	871
**Paneling	7314	4723	472	2119
**Timbers (PP)	6192	3920	392	1880
**Timbers (LP) + (SF)	6192	3878	388	1926
**Timbers (D≤5yrs)	6192	3944	394	1804
**Railroad Ties (PP)	5268	3980	398	890
**Railroad Ties (LP) + (SF)	5268	3938	594	936
**Railroad Ties (D≤5yrs)	5268	4004	400	864
***Boards P (D≤5)	3474	3297	330	153
***Barn Poles (All)	-	-	-	- (Very High)
***Houselogs (All)	-	-	-	- (Very High)
***Corral P (All)	-	-	-	- (Very High)
***Boards P (All)	-	-	-	- (Very High)
***Studs (All)	-	-	-	- (Very High)
***Pallets (All)	-	-	-	- (Very High)
***Fencing (All)	-	-	-	- (Very High)
***Dimension (All)	-	-	-	- (Very High)
***Firewood (All)	-	-	-	- (Very High)
***Chips	-	-	-	- (Very High)
***Shavings	-	-	-	- (Very High)
***Sawdust	-	-	-	- (Very High)

900-1300 Mile Marketing Area Zone

<u>Products</u>	<u>MR</u>	<u>MC</u>	<u>P + R</u>	Residual
Boards P (LP + SF)	4388	3409	341	533
**Paneling (D<5)	7314	4935	493	1336
Chips (G + D)	244	206	21	17
***Railroad Ties (All)	-	-	-	- 532
***Timbers (All)	-	-	-	- 32
***Boards P (PP)	-	-	-	-163
***Boards P (D<5)	-	-	-	-335
***Other Products	-	-	-	- (Very High)

Table I-15 Cost Breakdown Sheet for Fort Collins-Loveland Processing Center

PRODUCTS (FC-L)	STUMPAGE ¹		PROCUREMENT		MILLING		P&R %	TRANSP MCF (0-5)	TRANSP MCF (5-80)	TRANSP MCF (80-200)
	MBF	MCF	MBF	MCF	MBF	MCF				
Pallets(PP)	3.00	36.00	64.51	774	119.99	1440	.10	4.00	105.00	368.00
Pallets(LP)	4.00	48.00	60.01	720	"	"	"	"	"	"
Pallets(SF)	"	"	"	"	"	"	"	"	"	"
Pallets(D<5 yrs)	.50	6.00	69.01	828	"	"	"	"	"	"
Timbers(PP)	3.00	36.00	64.51	774	165	1980	.10	3.20	95.20	279.61
Timbers(LP)	4.00	48.00	60.01	720	"	"	"	"	"	"
Timbers(SF)	"	"	"	"	"	"	"	"	"	"
Timbers(D<5 yrs)	.50	6.00	69.01	828	"	"	"	"	"	"
Fencing(PP)	3.00	36.00	64.51	774	145.69	1748	.10	3.25	8928	303.97
Fencing(LP)	4.00	48.00	60.01	720	"	"	"	"	"	"
Fencing(SF)	"	"	"	"	"	"	"	"	"	"
Fencing(D<5 yrs)	.50	6.00	69.01	828	"	"	"	"	"	"
Dimension ² L (PP)	3.00	36.00	64.51	774	119.99	1440	.10	1.80	54.00	-
Dimension L (LP)	4.00	48.00	60.01	720	"	"	.10	"	"	-
Dimension L (SF)	"	"	"	"	"	"	.10	"	"	-
Dimension L(D<5 yrs)	.50	6.00	69.01	828	"	"	.10	"	"	-
RR Ties(PP)	3.00	36.00	64.51	774	170	2040	.10	3.20	96.15	282.50
RR Ties(LP)	4.00	48.00	60.01	720	"	"	"	"	"	"
RR Ties(SF)	"	"	"	"	"	"	"	"	"	"
RR Ties(D<5 yrs)	.50	6.00	69.01	828	"	"	"	"	"	"
Firewood(D<5)	.50	6.00	40.58	487	0	0	.10	1760	374.95	-
Firewood(D>5)"	"	"	41.58	499	"	"	.10	"	"	-
Chips(D)	-	-	-	-	3.00	36.00	.10	5.81	101.79	-
Chips(G)	-	-	-	-	"	"	.10	"	"	-
Shavings	-	-	-	-	3.00	36.00	.10	5.81	101.79	-
Sawdust	-	-	-	-	3.00	36.00	.10	5.81	101.79	-

¹All figures are \$/MBF or \$/MCF as indicated

²Dimension L. refers to dimension lumber

Table I-15 (cont)

PRODUCTS	TRANSP	TRANSP	PROD V ³		PROD V		PROD V		PROD V		PROD V	
	(200-900)	(900-1300)	(0-5)		(5-80)		(80-200)		(200-800)		(800-1300)	
	MCF	MCF	MBF	MCF	MBF	MCF	MBF	MCF	MBF	MCF	MBF	MCF
Pallets(PP) -	-	-	250	3000	250	3000	250	3000	250	3000	-	-
Pallets(LP) -	-	-	"	"	"	"	"	"	"	"	-	-
Pallets(SF) -	-	-	"	"	"	"	"	"	"	"	-	-
Pallets(D<5 yrs)	-	-	"	"	"	"	"	"	"	"	-	-
Timbers(PP) 1130		2085	310	3720	270	3240	449	5388	516	6192	440	5230
Timbers(LP) "	"	"	"	"	"	"	"	"	"	"	"	"
Timbers(SF) "	"	"	"	"	"	"	"	"	"	"	"	"
Timbers(D<5 yrs)	"	"	"	"	"	"	"	"	"	"	"	"
Fencing(PP) -	-	-	270	3240	270	3240	270	3240	-	-	-	-
Fencing(LP) -	-	-	"	"	"	"	"	"	-	-	-	-
Fencing(SF) -	-	-	"	"	"	"	"	"	-	-	-	-
Fencing(D<5 yrs)	-	-	"	"	"	"	"	"	-	-	-	-
Dimension L (PP)	-	-	220	2640	200	2400	-	-	-	-	-	-
Dimension L (LP)	-	-	"	"	"	"	-	-	-	-	-	-
Dimension L (SF)	-	-	"	"	"	"	-	-	-	-	-	-
Dimension L(D<5yrs)	-	-	"	"	"	"	-	-	-	-	-	-
RR Ties(PP) 1130		2085	310	3720	284	3410	374	4488	439	5268	400	4800
RR Ties(LP) "	"	"	"	"	"	"	"	"	"	"	"	"
RR Ties(SF) "	"	"	"	"	"	"	"	"	"	"	"	"
RR Ties(D<5 yrs)	"	"	"	"	"	"	"	"	"	"	"	"
Firewood (D<5)	-	-	49	588	64	768	-	-	-	-	-	-
Firewood (D>5)	-	-	"	"	"	"	-	-	-	-	-	-
Chips(D)	-	167	169.87	-	75	-	187	-	-	-	-	244
Chips(G)	-	"	-	-	75	-	187	-	-	-	-	244
Shavings	-	-	-	-	75	-	187	-	-	-	-	-
Sawdust	-	-	-	-	75	-	187	-	-	-	-	-

³PROD V - (product value) refers to the marginal revenue from each product in a given market zone.

Table I-15 (cont)

PRODUCTS (FC-L)	STUMPAGE		PROCUREMENT		MILLING		P&R %	TRANSP	TRANSP	TRANSP
	MBF	MCF	MBF	MCF	MBF	MCF		MCF (0-5)	MCF (5-80)	MCF (80-200)
Studs (PP)	3.00	54.85	64.51	1179	80.09	1646	.10	2.74	82.28	167.85
Studs (LP)	3.00	73.14	60.01	1097	"	"	"	"	"	"
Studs (SF)	4.00	"	"	"	"	"	"	"	"	"
Studs (D<5)	.50	9.14	69.01	1261	"	"	"	"	"	"
Panelling (D<5)	.50	9.14	69.01	1261	170.49	3117	.10	2.74	61.61	164.40

Table I-15 (cont)

PRODUCTS (FC-L)	STUMPAGE MBF MCF		PROCUREMENT MBF MCF		MILLING MBF MCF		P&R as Decimal	TRANSP MCF (0-5)	TRANSP MCF (5-80)	TRANSP MCF (80-200)
Barn poles (PP)	2.00	2400	64.51	774	163.09	1957	.10	3.18	86.95	291.39
Barn poles (LP)	3.00	36.00	60.01	720	"	"	"	"	"	"
Barn poles (SF)	"	"	"	"	"	"	"	"	"	"
Barn poles (D<5)	.50	6.00	69.01	828	"	"	"	"	"	"
Houselogs (PP)	2.00	24.00	64.51	774	57.49	690	.10	320	90.38	279.63
Houselogs (LP)	3.00	36.00	60.01	720	"	"	"	"	"	"
Houselogs (SF)	"	"	"	"	"	"	"	"	"	"
Houselogs (D<5)	.50	6.00	69.21	82.8	"	"	"	"	"	"
Corral P(PP)	2.00	24.00	41.37	496	173.60	2083	.10	3.22	88.06	295.14
Corral P(LP)	3.00	36.00	39.40	473	"	"	"	"	"	"
Corral P(SF)	"	"	"	"	"	"	"	"	"	"
Corral P (D<5)	.50	6.00	43.34	520	"	"	"	"	"	"
Fence P(PP)	2.00	24.00	41.37	496	162.73	1953	.10	3.22	88.06	295.14
Fence P(LP)	3.00	36.00	39.40	473	"	"	"	"	"	"
Fence P(SF)	"	"	"	"	"	"	"	"	"	"
Fence P (D<5)	.50	5.00	43.34	520	"	"	"	"	"	"
BoardsR(PP)	3.00	36.00	64.51	774	59.99	720	.10	1.80	54.00	-
BoardsR(LP)	4.00	48.00	60.01	720	"	"	"	"	-	-
BoardsR(SF)	"	"	"	"	"	"	"	"	-	-
BoardsR (D<5yrs)	.50	6.00	69.01	828	"	"	"	"	-	-
BoardsP(PP)	3.00	54.85	64.51	1179	92.49	1691	.10	2.74	8228	167.85
BoardsP(LP)	4.00	73.14	60.01	1097	"	"	"	"	"	"
BoardsP(SF)	"	"	"	"	"	"	"	"	"	"
BoardsP (D<5yrs)	.50	9.14	69.01	1261	"	"	"	"	"	"

Table I-15 (cont)

PRODUCTS	TRANSP (200-900)		TRANSP (900-1300)		PROD V (0-5)		PROD V (5-80)		PROD V (80-200)		PROD V (200-900)		PROD V (900-1300)	
	MCF		MCF		MBF	MCF	MBF	MCF	MBF	MCF	MBF	MCF	MBF	MCF
Barn Poles - (PP)	-		-		280	5360	297	3.564	224	3408	-	-	-	-
BarnPoles(LP)-	-		-		"	"	"	"	"	"	-	-	-	-
BarnPoles(SF)-	-		-		"	"	"	"	"	"	-	-	-	-
BarnPoles - (D<5yrs)	-		-		"	"	"	"	"	"	-	-	-	-
Houselogs(PP)-	-		-		155	1860	167	2004	162	1944	-	-	-	-
Houselogs(LP)-	-		-		"	"	"	"	"	"	-	-	-	-
Houselogs(SF)-	-		-		"	"	"	"	"	"	-	-	-	-
Houselogs - (D<5yrs)	-		-		"	"	"	"	"	"	-	-	-	-
CorralP(PP) -	-		-		240	2880	267	3204	251	3012	-	-	-	-
CorralP(LP) -	-		-		"	"	"	"	"	"	-	-	-	-
CorralP(SF) -	-		-		"	"	"	"	"	"	-	-	-	-
CorralP - (D<5yrs)	-		-		"	"	"	"	"	"	-	-	-	-
FenceP(PP) 1137	-		-		281	3372	339	4069	378	4536	339	4069	-	-
FenceP(LP) "	-		-		"	"	"	"	"	"	"	"	-	-
FenceP(SF) "	-		-		"	"	"	"	"	"	"	"	-	-
FenceP (D<5yrs) "	-		-		"	"	"	"	"	"	"	"	-	-
BoardsR(PP) -	-		-		150	1800	140	1680	-	-	-	-	-	-
BoardsR(LP) -	-		-		"	"	"	"	-	-	-	-	-	-
BoardsR(SF) -	-		-		"	"	"	"	-	-	-	-	-	-
BoardsR - (D<5yrs)	-		-		"	"	"	"	-	-	-	-	-	-
BoardsP(PP) 335.78	-		-		200	3657	200	3657	180	3291	200	3657	-	-
BoardsP(LP) "	548.54		-		210	3840	210	3840	190	3474	240	4388	240	4388
BoardsP(SF) "	"		-		"	"	"	"	"	"	"	"	"	"
BoardsP (D<5yrs) "	-		-		190	3474	190	3474	175	3200	190	3474	-	-
Studs(PP) 335.98	-		-		180	3291	180	3291	170	3108	200	3657	-	-
Studs(LP) "	-		-		"	"	"	"	"	"	"	"	-	-
Studs(SF) "	-		-		"	"	"	"	"	"	"	"	-	-
Studs(D<5) "	-		-		175	3200	175	3200	165	3017	195	3200	-	-
Panelling (D<5yrs) 335.98	548.54		-		300	5485	380	6.948	400	7.314	400	7.314	400	7314

CASE STUDY I - FORT COLLINS-LOVELAND TRIBUTARY AREA

Summary Analysis

The intent of this section is to assess the results of the four alternatives as illustrated in the various figures and tables displayed earlier. Consideration will be given to highlighting favorable mixes of products within each individual alternative as well as for the entire case study. The examination will attempt to locate product mixes favorable in terms of total return, return due to ponderosa pine, and wood utilization. Tradeoffs of products in different market zones and total return added over market zones will be examined to determine the most favorable sets of products to market in a given market zone. This examination will also study where additional profits could be realized if a different allocation was used. Products not currently marketed but which show marked promise for good profit return will also be presented along with those currently marketed but which show marked promise for good profit return will also be presented along with those currently marketed products that reveal losses, if any. Lastly, a sensitivity analysis will be presented which when altering one of the input factors will attempt to discover what some of the dynamic factors and relationships are in the market model.

Raw Material Supply Versus Amount Consumed

In each alternative, the total supply of raw material was found to exceed the total consumed by as much as 6100 MCF in Alternative #3. Thus, each production capacity was completely exhausted leaving substantial residual raw material remaining under each alternative. The combination of cuts used in each alternative would yield an excess of timber even in the last

alternative study which was based on current supply and current capacity figures. To further this conclusion, given the cutting schedules in each alternative, including the last, profit potential is undermined by lack of production capacity.

Utilization of All Ponderosa Pine Types

The supply distribution section of Tables I-6, 7, 8 and 9 depicts the supply of ponderosa pine under different cutting schedules, reflective of the goals and constraints. Total ponderosa pine used per alternative study is as follows:

Alternative	1	2	3	4
MCF	3077.1	1778	474.1	254.2

Thus, strictly in terms of utilization of all types of ponderosa pine, Alternative #1 has the highest amount used. Despite the fact that ponderosa pine comprised only 34% of supply, it was used at a rate of about 55% of the total consumed. In no other alternative did ponderosa pine comprise more than 35% of that which was used. As would be assumed, the overriding goal in this case was maximization of recommended ponderosa pine cuts.

Utilization of Beetle-killed Ponderosa Pine

In terms of utilization of dead ponderosa pine, Alternative #2 utilized the entire supply, realizing the greatest profit due strictly to dead ponderosa pine.

Overall Returns to Stumpage

Alternative #1 yielded the greatest returns from ponderosa pine dead and live combined, comprising about 70% of total returns. Again in

Alternative #1, about 55% of product used was ponderosa pine, thus illustrating a very high portion of raw material used and a higher portion of returns.

Alternative #2 yielded a \$939,934 return (residuals) from dead ponderosa pine alone, reflecting the goal of utilization of previous year mortality. This alternative perhaps best illustrates the opportunities for profit represented by dead ponderosa pine, based on about 40% of supply used.

The highest profit return to stumpage, \$1,949,832, was in Alternative #3. It was \$920,000 greater than current total profit estimates, although it represented a small use of ponderosa pine.

Market Consumption of Products

Market allocations may hold the key to the optimum mix of materials to use and products to produce. In reference to market consumption, Table I-11 and I-12 are of particular importance. Table I-11 displays the allocation of products to market zones in terms of raw materials and quantity. Table I-12 effectively sums the quantities in Table I-11 at their predetermined residual rates per MCF, given in Table I-15. With profit maximization in mind, the goal program will attempt to allocate all raw materials to those products in market zones which will yield the greatest return. A quick examination of Table I-11 will show which products have the greatest value in which zones. For example, in the 80-200 zone, timbers appear in each alternative allocation. In this zone, timber residual ranges from \$1,985 to \$2,057 per MCF of product, depending on raw material source. Accordingly, the residual ranges for timbers in the 5-80 miles zone is \$41 to \$113 and \$621 to \$683 per MCF of product in the local area. This may help to guide the allocation of ponderosa pine products to those markets which would yield the greatest returns to stumpage. As in Alternative #2, high returns may be obtained from distant markets for ponderosa pine.

General Consumption Breakdown

The general consumption of products to market zones appears to follow the general trend below: (when given no demand constraints)

0-5 mile	pallets	5-80 mile	houselogs
	fencing		barnpoles
	rough boards		corral poles
	dimension lumber		chips
	studs		sawdust
	firewood		shavings
80-200 mile	timbers	200-900 mile	paneling
	fence posts		planed boards
	railroad ties		

Optimum Ponderosa Pine Utilization

Overall, the greatest potential for utilization of ponderosa pine lies in Alternative #1, which also yields the highest total ponderosa dead and live profit. Alternative #2, though having a somewhat lesser ponderosa utilization level, yields a near equal profit based on dead ponderosa alone. For the purpose of maximizing utilization of ponderosa pine and total profits, it appears as though a cross between the first and second alternatives would yield the best results for the Fort Collins-Loveland area.

Product Profit Potentials

The list of products and the distance they are marketed as used in this study varies to a degree with the current marketing picture. The study of revenue and cost figures in Table I-15 has shown, in many cases, product profit potentials for more distant zones than those presently utilized. These products include the following:

80-200 mile zone:

<u>Products</u> ^{1/}	<u>Returns to Stumpage(\$/MCF of roundwood)</u>
studs-sf,Lp	12.50
pallets-PP	60.00
pallets-sf,Lp	83.00
pallets-D<5	57.82

200-900 mile zone:

<u>Products</u>	<u>Returns to Stumpage(\$/MCF)</u>
fence posts-PP	98.00
fence posts-sf,Lp	110.00
fence posts-D<5	55.97
paneling-D<5	1,303.40
timbers-PP	940.00
timbers-sf,Lp	963.00
timbers-D<5	1,109.60
railroad ties-PP	445.00
railroad ties-sf,Lp	468.00
railroad ties-D<5	531.40

^{1/}sf=spruce-fir, Lp=lodgepole pine, PP=ponderosa pine, D<5=PP dead<5 yrs.

The program as written presently reflects these products and they form part of the consumption and profit figures in the 80-200 mile and 200-900 mile zones. While these products have substantially higher costs of production than their counterparts sold in closer zones, the return to stumpage realized is proportionately higher in most cases.

Fort Collins-Loveland Tributary Area

Sensitivity Analysis

INTRODUCTION

As is suggested in the methodology portion of this study, many production factors could be analyzed to ascertain their individual or collective impacts on the results of each case study. This analysis will focus on a demand constraint on product consumption. Previously we have assumed a market area and population economically large enough to consume any probable supply of product from the Front Range. A restriction will now be imposed on this "open" market. Through the use of a maximum demand level in the first marketing zone the amount of products that will be consumed there will be limited in the program. The program presently allows the entire stock of a product to be allocated to one zone. Should the primary goal be to maximize returns to stumpage, and should a given product maximize its individual return in the initial zone, 0-5 miles, the entire stock of that product would be consumed there, according to the goal program. In as small a market area as the Pine-Bailey 0-5 mile zone, for example, the entire stock of pallets that might be produced there are not logically likely to be consumed there. The consumption constraint will limit the 0-5 mile area consumption of each product to 10% of that level consumed in the initial alternative results. Where 150 MCF of pallets may have been consumed in the 0-5 mile zone in our initial examination, now the consumption level is constrained to 15 MCF. This, of course, leaves 135 MCF to be marketed to other zones at greater distances from the processing center. This serves as the basis for the sensitivity analysis. As this discussion is presented here in full, only the basics of its intent will be repeated as other case study sensitivity analysis are presented.

ANALYSIS

As in the original goal program run, the supply of raw material available in each alternative exceeded the amount actually consumed. Also, in the sensitivity

analysis the amount of material consumed was less than that level consumed in the original analysis. (See Table I-16)

Resources Used (MCF of roundwood)					
ALTERNATIVE	1	2	3	4	
ORIGINAL ANALYSIS	4863	4722	4713	2228	MCF
SENSITIVITY ANALYSIS	3630	3813	3630	1925	MCF

This drop in the level of raw material used, or consumed, is due, in part, to the marginal analysis of products. Each product was analyzed in terms of marginal revenue, marginal costs, profit and risk factors to determine the residual return from the product in the individual marketing zones. (See Table I-14) As a result of this analysis some products were found to be uneconomical to market in certain zones due to a negative residual. Where this was the case, the product, through the goal program, was not made available for marketing, or consumption, in the uneconomical zone. In the Fort Collins-Loveland case study, this outcome resulted in some products being restricted to sales only in the 0-5 mile marketing zone. With the imposition of a constrained consumption level in the 0-5 mile market zone, many products were simply produced up to that specific level and further production terminated. The end result was a lower level of consumption of a given product and, thus, a lesser amount of raw material used. In this case study the products most affected by the consumption restriction combined with further restriction of uneconomical residuals in more distant market zones were firewood, studs and rough boards. (See Table I-11 and I-20)

The table below shows the difference in raw material used, by species type, between the original alternative and the sensitivity analysis. (Also see Table I-17)

Table I-16 Fort Collins-Loveland: SENSITIVITY STUDY

Raw Material Supply Versus Raw Material Used

ALTERNATIVE 1

Supply (MCF of roundwood)		Resources Used (MCF of roundwood)	
SFLP	sawtimber	4322.0	104.8
SFLP	poletimber	2460.0	761.5
PP	sawtimber	2358.0	2358.0
PP	poletimber	245.0	245.0
PP	dead<5 yrs	1564.0	160.6
PP	dead>5 yrs	<u>214.0</u>	<u>0.0</u>
TOTAL		11,163.0 MCF	3629.9 MCF

ALTERNATIVE 2

Supply (MCF of roundwood)		Resources Used (MCF of roundwood)	
SFLP	sawtimber	4322.0	1750.2
SFLP	poletimber	2460.0	478.2
PP	sawtimber	1440.0	0.0
PP	poletimber	820.0	0.0
PP	dead<5 yrs	1564.0	1564.0
PP	dead>5 yrs	<u>214.0</u>	<u>21.4</u>
TOTAL		10,820.0 MCF	3813.8 MCF

ALTERNATIVE 3

Supply (MCF of roundwood)		Resources Used (MCF of roundwood)	
SFLP	sawtimber	4322.0	2462.8
SFLP	poletimber	2460.0	1006.5
PP	sawtimber	1440.0	0.0
PP	poletimber	820.0	0.0
PP	dead<5 yrs	1564.0	160.6
PP	dead>5 yrs	<u>214.0</u>	<u>0.0</u>
TOTAL		10,820.0 MCF	3629.9 MCF

ALTERNATIVE 4

Supply (MCF of roundwood)		Resources Used (MCF of roundwood)	
SFLP	sawtimber	1982.0	1228.6
SFLP	poletimber	495.0	495.0
PP	sawtimber	660.0	0.0
PP	poletimber	165.0	117.6
PP	dead<5 yrs	1564.0	84.4
PP	dead>5 yrs	<u>214.0</u>	<u>0.0</u>
TOTAL		5080.0 MCF	1925.6 MCF

Raw Material Used--Original Alternative Versus
Sensitivity Alternative (MCF of roundwood)

SFLP	sawtimber	*Alt1-Alt1-S	Alt2-Alt2-S	Alt3-Alt3-S	Alt4-Alt4-S
SFLP	poletimber	920.2	583.4	769.9	250.3
PP	sawtimber	0	132.4	0	0
PP	poletimber	0	0	0	0
PP	dead<5 yrs	0	0	313.5	52.2
PP	dead>5 yrs	313.5	192.6	0	0

*Alt 1-S refers to the sensitivity analysis program run
using Alternative/constraints and goals outlined in
Table I-6.

Based on the lower consumption and use of products and raw material, the returns to stumpage for each alternative are less in the sensitivity analysis than in the original alternative. This is due to two reasons. First, some products will maximize residual return if marketed in the first market zone. The market zone consumption for that product is limited and the remaining production capacity of that product is consumed in more distant markets, often at a lower rate of return. This results in lower returns for the majority of that product sold and lesser total revenue accruing to that product as compared to the original alternative.

Secondly, in reference to material discussed earlier, when market consumption was severely restricted due to the combination of consumption limitation and uneconomical residuals in zones beyond the 0-5 mile marketing zone, product consumption and resource use was curtailed, eliminating a residual return associated with it. Tables I-19 and 20 reveal this loss. The table below illustrates the differences in total returns by zones between the original alternatives and the sensitivity analysis alternatives.

Difference in Returns to Stumpage-Original

Alternative-Sensitivity Alternative

	<u>0-5 mile</u>	<u>5-80 mile</u>	<u>80-200 mile</u>	<u>200-900 mile</u>	<u>TOTAL DIFFERENCE</u>
ALT1-ALT1-S	\$518,039	-338,220	0	0	179,819
ALT2-ALT2-S	\$264,974	-134,379	0	0	130,595
ALT3-ALT3-S	\$294,122	-164,093	0	0	129,025
ALT4-ALT4-S	\$135423	-83,471	0	0	51,952

Due to the demand limitation, the consumption pattern remained the same. The following table lists the general consumption pattern of products as compared to the general consumption in the original alternatives. As is expected, the consumption pattern is now drawn out to further distant markets to utilize the supply. As a result, less revenue is received per MCF of a given product.

General Product Consumption Breakdown

	<u>Original Alternatives/Sensitivity</u>	
0-5 Mile zone	pallets fencing boards rough dimension lumber studs firewood	pallets fencing boards rough dimension lumber studs firewood
5-80 Mile zone	housetlogs barn poles corral poles chips shavings sawdust	pallets fencing studs housetlogs barn poles corral poles chips shavings sawdust
80-200 Mile zone	timbers fence poles railroad ties	timbers fence poles railroad ties
200-900 Mile zone	panelling planed boards	panelling planed boards

Exact amounts of these products are listed in Tables I-11 and 19.

Table I-17 - Fort Collins-Loveland: SENSITIVITY STUDY

Raw Material Supply versus Raw Material Consumed

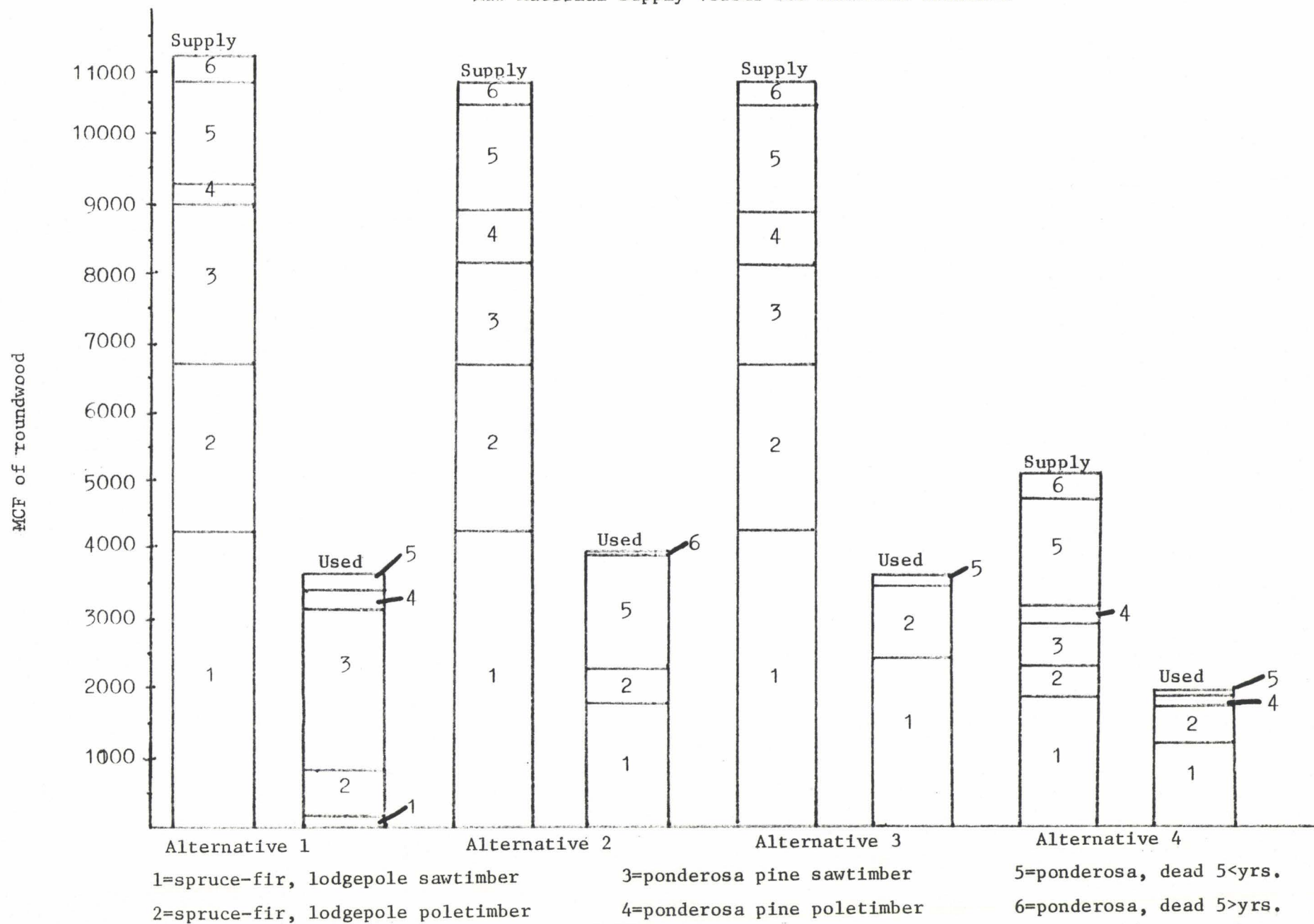


Table I-18 Fort Collins-Loveland SENSITIVITY STUDY

Total Returns Per Market Zone and Alternative

		0-5	5-80	80-200	200-900
ALT					
1	Total Returns	\$57,407.70	\$624,190.45*	\$623,139.50	\$164,010.60
	due to PP live	49,138.60	349,505.90	491,476.70	0.00
	due to PP dead	556.40	0.00	0.00	164,010.00
	due to SFLP	7,712.70	226,167.20	131,662.80	0.00
ALT					
2	Total Returns	\$29,920.90	\$414,905.25*	\$558,347.50	\$708,302.40
	due to PP live	0.00	0.00	0.00	0.00
	due to PP dead	18,939.20	166,951.90	558,347.50	164,010.60
	due to SFLP	10,481.70	199,436.00	0.00	544,200.80
ALT					
3	Total Returns	\$32,655.50	\$450,585.10*	\$629,400.70	\$708,302.40
	due to PP live	0.00	0.00	0.00	0.00
	due to PP dead	556.40	0.00	0.00	164,010.60
	due to SFLP	32,099.10	400,773.90	629,400.70	544,200.80
ALT					
4	Total Returns	\$15,527.80	\$248,871.06*	\$380,119.20	\$336,729.90
	due to PP live	0.00	28,694.40	0.00	0.00
	due to PP dead	556.40	0.00	0.00	64,629.50
	due to SFLP	14,971.40	194,998.20	380,119.20	272,100.40

* chips, shavings, sawdust included in this value

Table I-19 Fort Collins-Loveland SENSITIVITY STUDY

Returns to Stumpage (Residual)

ALT	REVENUE DUE TO PONDEROSA PINE	REVENUE DUE TO DEAD PONDEROSA PINE	REVENUE DUE TO SPRUCEFIR LODGEPOLE	REVENUE DUE TO MILL RESIDUES	TOTAL REVENUE
1	\$890,121.20	164,567.00	365,542.70	48,517.35	\$1,468,748.20
2	\$ 0.00	908,249.20	754,118.50	48,517.35	\$1,710,885.00
3	\$ 0.00	164,567.00	1,606,474.50	49,811.20	\$1,820,852.70
4	\$ 28,694.40	65,185.90	862,189.20	25,178.46	\$ 981,247.96

Table I-20 Fort Collins-Loveland SENSITIVITY STUDY

Market Consumption: Resources to Products (MCF of roundwood)

Alternative 1			Alternative 2		Alternative 3		Alternative 4	
0-5 mile zone	Pallets (PP)	43.0	Pallets (D<5)	35.0	Pallets (SFLP)	43.0	Pallets(SFLP)	18.6
	fencing (PP)	48.2	fencing (D<5)	32.7	fencing (SFLP)	40.2	fencing (SFLP)	23.4
	boards R(SFLP)	88.8	boards R(SFLP)	88.8	boards R(SFLP)	88.8	boards R(SFLP)	31.2
	boards p(PP)	124.6						
	dimension L(SFLP)	5.4	dimension L(SFLP)	5.4	dimension L(SFLP)	5.4	dimension L(SFLP)	3.2
	studs(PP)	14.2	studs (SFLP)	14.1	studs (SFLP)	14.1	studs (SFLP)	7.0
	firewood (D<5)	34.8	firewood(D>5)	21.4	firewood(D<5)	34.8	firewood(D<5)	34.8
5-80 mile zone	pallets(PP)	387.2	pallets(D<5)	314.7	pallets(SFLP)	387.2	pallets(SFLP)	167.2
	fencing(PP)	362.6	fencing(D<5)	79.5	fencing(SFLP)	362.6	fencing(SFLP)	209.6
	boards P(PP)	1125.0						
	houelogs(SFLP)	147.3	houelogs(SFLP)	147.3	houelogs(SFLP)	147.3	houelogs(SFLP)	100.4
	barn poles(SFLP)	195.7	barn poles(D<5)	318.2	barn poles(SFLP)	195.7	barn poles(SFLP)	116.6
	corral p(SFLP)	330.9	corral p(SFLP)	330.9	corral p(SFLP)	330.9	corral p(PP)	117.6
	studs(SFLP)	10.6	studs(SFLP)	127.4	studs(SFLP)	127.4	studs(SFLP)	63.8
	chips*	666.18	chips*	666.18	chips*	691.05	chips*	340.45
	sawdust	324.26	sawdust	324.26	sawdust	336.36	sawdust	165.71
	shavings	395.77	shavings	395.77	hsavings	395.77	shavings	213.22
80-200 mile zone	timbers(PP)	105.4	timbers(D<5)	85.7	timbers(SFLP)	105.4	timbers(SFLP)	79.8
	fence poles(PP)	245.0	fence poles(D<5)	540.7	fence poles(SFLP)	332.6	fence poles(SFLP)	198.3
	fence poles(SFLP)	87.6						
	RR ties(PP)	39.0	RR ties(D<5)	31.7	RR ties(SFLP)	39.0		
200- 900 mile zone			boards p(SFLP)	1249.6	boards p(SFLP)	1249.6	boards p(SFLP)	624.8
	panelling(D<5)	125.8	panelling(D<5)	125.8	panelling(D<5)	125.8	panelling(D<5)	49.6

PP = ponderosa pine, SFLP = spruce-fir, lodgepole pine

*values for mill residues are in terms of product, not roundwood

CASE STUDY II: Boulder-Longmont Case Study

The Boulder-Longmont case study has a timber procurement base of over 330,000 acres. This procurement acreage was developed in CSU Project #2192. (As detailed earlier in this report, the procurement zone encompasses the area of present or potential supply for area mills.) To avoid the capacity of overlapping procurement areas between processing centers, the center holding a competitive advantage was considered to be the sole timber buying center. The Boulder-Longmont procurement area encompasses private and state land in Boulder and Gilpin Counties, and portions of Jefferson County, as well as part of the Roosevelt National Forest. Figure II-1 illustrates as a percentage, the ownership portions in the procurement area as well as accessible acreage within these areas. Table II-1 lists acreage totals for each ownership.

The timber supply in terms of allowable cut, current cut, and recommended annual cut was obtained from CSU Project #2192. The raw material supply, as displayed in Table II-2 illustrates the cut determination.

The four alternatives for this case study will display the individual input values to represent the four sets of overriding goals. The constraint would represent types and levels of timber cut per species and mill capacities for various products with a standard profit per product for all subsequent alternatives.

Production capability is drawn in Table II-3 with Table II-4 displaying current annual production for area mills. A definition of the products produced in the Boulder-Longmont center and their respective conversion factors is shown in Table II-5. This table displays the products standard finished size, the amount of wood per product and in appropriate cases, a conversion from cubic feet of product to board feet.

The result of implementing each alternative are shown briefly in Tables II-6 through II-9. The tables show the constraints and goals for each goal program run. Raw material supply, as well as product capacity reflective of the above constraints, are also shown.

Resources used from different material classes are also displayed adjacent to raw material available, in the form of percentages in Table II-10. Thus, by examining the output strictly in terms of supply, the observer may determine the impact of a certain alternative strategy on the consumption of a certain size and species class of timber relative to the others. The total amount of each material class is broken down into ultimate products in Table II-11. The total return due to the allocation of raw materials to given products is illustrated in Table II-12. The table sums residual values for given numbers of products sold in a market area by raw material class. The material classes here are grouped into ponderosa pine live which includes sawtimber and poletimber, ponderosa pine dead which includes dead > 5 years, and spruce-fir and lodgepole materials grouped together.

Table II-13, returns to stumpage, shows the total residual distribution in each alternative by material class, enabling the observer to quickly note what amount, for example, of a total return is due to dead and beetle-killed ponderosa pine.

Figure II-1 - Boulder-Longmont Tributary Area

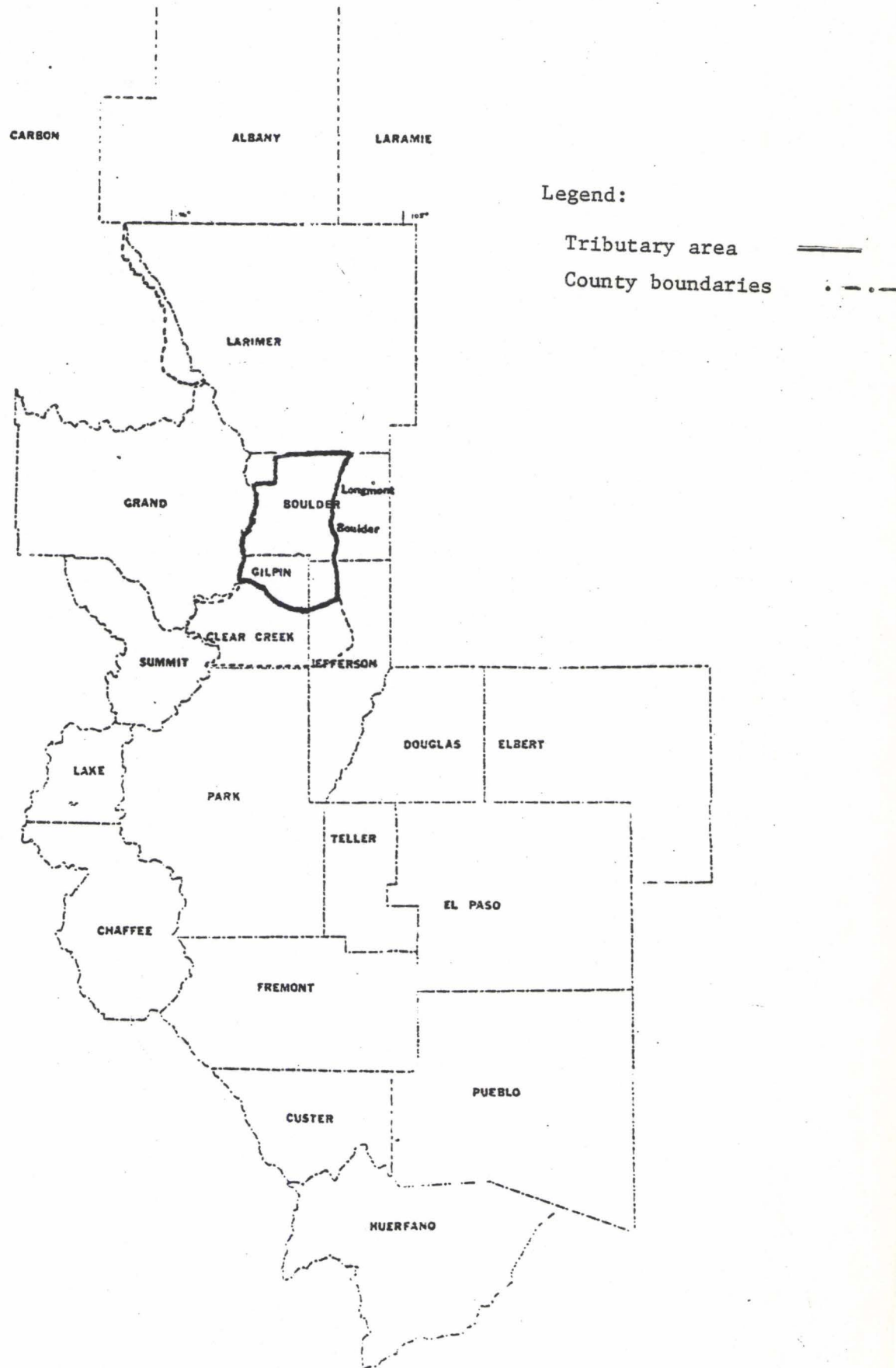


Figure II-2 - Boulder-Longmont

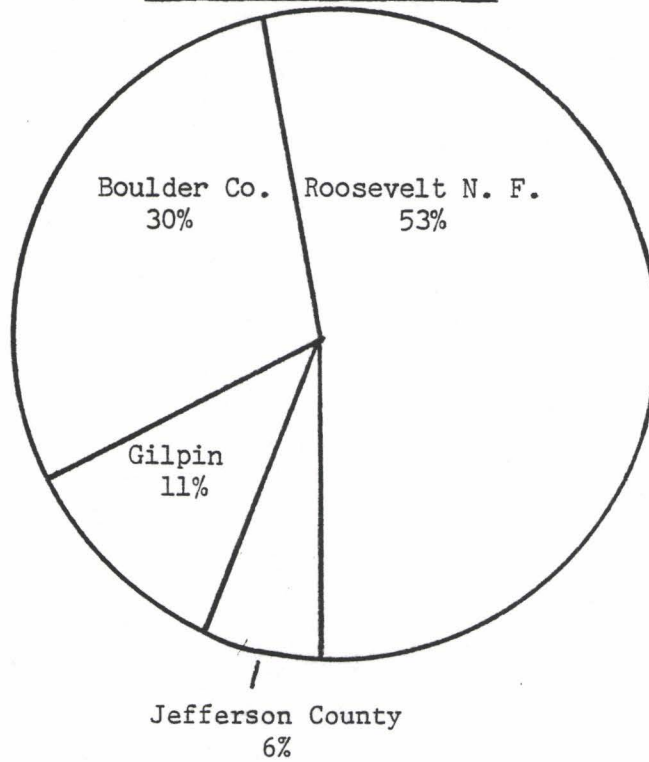
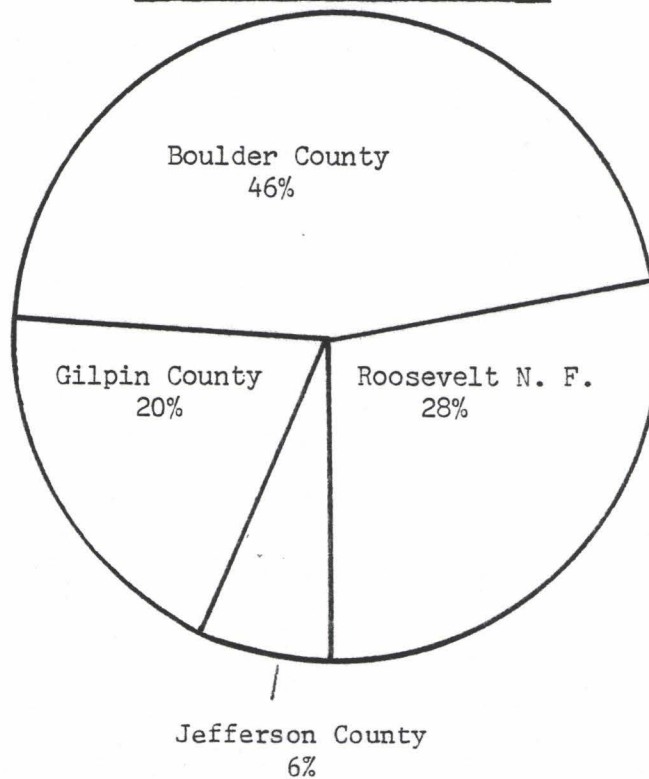
Timber Procurement AreaTotal Procurement AreaAccessible Commercial Area

Table II-1 Boulder-Longmont

Timber Procurement AreaPROCUREMENT AREA:

Roosevelt National Forest	177,316 acres
Boulder County (state & private):	99,700
Gilpin County (state & private):	38,800
Jefferson County (state & private):	20,000
Total:	335,816 acres
(forested acres, at least 10% stocked)	

ACCESSIBLE COMMERCIAL FOREST LANDS - PROCUREMENT AREA:^{1/}

Roosevelt National Forest:	43,183 acres
Boulder County (state & private):	70,900
Gilpin County:	31,900
Jefferson County:	9,383
Total:	155,366 acres

^{1/} Standard and special component areas on national forest land, all state and private lands.

Table II-2 Boulder-Longmont
Raw Material Supply

Allowable Cut

Species	Size Class	bdft/cuft	allowable	bdft/cuft	product
Ponderosa pine	sawtimber	5 / 1	980, MCF	10/1	490 MCF
Ponderosa pine	poletimber	5 / 1	720	5/1	720
Spruce-fir	sawtimber	5 / 1	392	10/1	196
Spruce-fir	poletimber	5 / 1	288	5/1	288
Lodgepole	sawtimber	5 / 1	588	10/1	294
Lodgepole	poletimber	5 / 1	432	5/1	432

Current Cut

Species	Size Class	bdft/cuft	current	bdft/cuft	product
Ponderosa pine	sawtimber	5 / 1	353 MCF	10/1	176 MCF
Ponderosa pine	poletimber	5 / 1	88	5/1	88
Spruce-fir	sawtimber	5 / 1	141	10/1	70
Spruce-fir	poletimber	5 / 1	35	5/1	35
Lodgepole	sawtimber	5 / 1	212	10/1	106
Lodgepole	poletimber	5 / 1	53	5/1	53

Recommended Cut

Species	Size Class	bdft/cuft	recommend	bdft/cuft	product
Ponderosa pine	sawtimber	5 / 1	1,634 MCF	10/1	817 MCF
Ponderosa pine	poletimber	5 / 1	360	5/1	360
Ponderosa pine (dead < 5 yrs)		5 / 1	2,058	8/1	1,266
Ponderosa pine (dead > 5 yrs)		5 / 1	275	5/1	275

Table II-3 - Boulder-LongmontMaximum Mill Production Capacity 1/

<u>PRODUCT</u>	<u>OUTPUT CAPACITY</u>	<u>OUTPUT CAPACITY</u>
Rough boards	567.1MCF OF PRODUCT	1134.2 MCF OF ROUNDWOOD
Planed boards	39.4	78.8
Barn poles	112.9	112.9
Corral poles	22.5	22.5
Fence posts	37.2	37.2
Houselogs	40.2	40.2
Panelling	52.5	85.3
Dimension lumber	58.6	117.2
Firewood	275.4	447.7
Railroad ties	48.9	97.8
Chips	428.3	
Sawdust	209.2	
Shavings	55.3	

1/ based on an 8 hr. day, 240 days/yr

Table II-4 - Boulder-Longmont

<u>Current Annual Product Production</u>		
<u>PRODUCT</u>	<u>OUTPUT</u>	<u>OUTPUT</u>
Rough boards	147.1 MCF OF PRODUCT	294.2 MCF OF ROUNDWOOD
Planed boards	13.8	27.6
Barn poles	37.6	37.6
Corral poles	7.5	7.5
Fence posts	12.4	12.4
Houselogs	26.8	26.8
Panelling	18.4	29.9
Dimension lumber	24.9	49.8
Firewood	68.8	110.5
Railroad ties	29.3	58.6
Chips	131.6	
Sawdust	64.2	
Shavings	20.2	

Table II-5 - Boulder-LongmontProduct Definition and Conversion Factors

Rough boards	1"x4"		81.47 cuft/MBF
Planed boards	1"x4"		54.69 cuft/MBF
Barn poles	6"x20'	3.92 cuft/pole	
Corral poles	3"x16'	.78 cuft/pole	
Fence posts	3.5"x6.5'	.43 cuft/post	
Houselogs	8"x16'	5.58 cuft/houselog	tongue & grooved
Panelling	1"x4"		54.69 cuft/MBF
Dimension lumber	3"x6"		81.47 cuft/MBF
Firewood	4'x4'8"	85 cuft/cord	
Railroad ties	6"x4"x 6'	1 cuft/tie	treated
Chips	43 cuft/MBF		
Sawdust	21 cuft/MBF		
Shavings	16 cuft/MBF		

Table II-6 - Boulder-Longmont

Alternative #1 Description

Constraints: -annual allowable cut on SF, LP
 -recommended PP cuts
 annual cut on mortality PP and salable dead
 -product capacity for each product

Goals: #1-minimize underachievement of recommended PP cuts
 #2-maximization of returns to stumpage

Raw Material Supply(MCF of roundwood)			Resources Used(MCF of roundwood)
SF-LP	sawtimber	980.0	0.0
SF-LP	poletimber	720.0	0.0
PP	sawtimber	1634.0	1428.0
PP	poletimber	360.0	212.8
PP	dead<5 yrs	2058.	533.0
PP	dead>5 yrs	275.0	0.0
TOTAL		6027.0	2173.8

Maximum Mill Production Capacity: (MCF of roundwood)

rough boards	1134.2
planed boards	78.8
houselogs	40.2
barn poles	112.9
corral poles	22.9
fence poles	37.2
panelling	85.3
dimension lumber	117.2
firewood	447.7
railroad ties	97.8

SF-LP = spruce-fir, lodgepole pine

PP = ponderosa pine

Table II-7 - Boulder-Longmont

Alternative #2 Description

Constraints: -annual allowable cut on SF, LP, PP
 -recommended annual cuts on mortality and
 salable dead

Goals: #1-minimize underachievement of removing
 previous year PP mortality
 #2-maximization of returns to stumpage

Raw Material Supply: (MCF of roundwood)			Resources Used: (MCF of roundwood)
SE-LP	sawtimber	980.0	0.0
SF-LP	poletimber	720.0	0.0
PP	sawtimber	980.0	0.0
PP	dead<5 yrs	2058.0	2039.6
PP	dead>5 yrs	275.0	0.0

Maximum Mill Production Capacity (MCF of roundwood)

rough boards	1134.2
planed boards	78.8
houselogs	40.2
barn poles	112.9
corral poles	22.9
fence poles	37.2
panelling	85.3
dimension lumber	117.2
firewood	447.7
railroad ties	97.8

Table II-8 - Boulder-Longmont

Alternative #3 Description

Constraints: -annual allowable cuts on SF, LP, PP
 -recommended annual cut on mortality PP
 and salable dead

Goals: #1-Maximization of returns to stumpage

Raw Material Supply(MCF of roundwood)			Resources Used (MCF of roundwood)
SF-LP	sawtimber	980.0	980.0
SF-LP	poletimber	720.0	212.8
PP	sawtimber	980.0	448.0
PP	poletimber	720.0	0.0
PP	dead<5 yrs	2058.0	533.0
PP	dead>5 yrs	275.0	0.0
TOTAL		5733.0	2173.8

Maximum Mill Production Capacity (MCF of roundwood)

rough boards	1134.2
planed boards	78.8
houselogs	40.2
barn poles	112.9
corral poles	22.9
fence poles	37.2
panelling	85.3
dimension lumber	117.2
firewood	447.7
railroad ties	97.8

Table II-9 - Boulder-Longmont

Alternative #4 Description

Constraints: -current cut level for LP,SF,PP
 -recommended annual cut for mortality PP
 and salable dead
 -current annual production levels for each
 product

Goals: #1-maximization of returns to stumpage

Raw Material Supply(MCF of roundwood)			Resources Used(MCF of roundwood)
SF-LP	sawtimber	352.0	352.0
SF-LP	poletimber	88.0	84.5
PP	sawtimber	352.0	78.2
PP	poletimber	88.0	0.0
PP	dead<5 yrs	2058.0	141.8
PP	dead>5 yrs	275.0	0.0
TOTAL		3213.0	656.5

Current Mill Production(MCF of roundwood)

rough boards	294.2
planed boards	27.6
houselogs	26.8
barn poles	37.6
corral poles	7.5
fence poles	12.4
panelling	29.9
dimension lumber	49.8
firewood	110.5
railroad ties	58.6

FIGURE II-3 - Market Area for Boulder-Longmont Processing Area

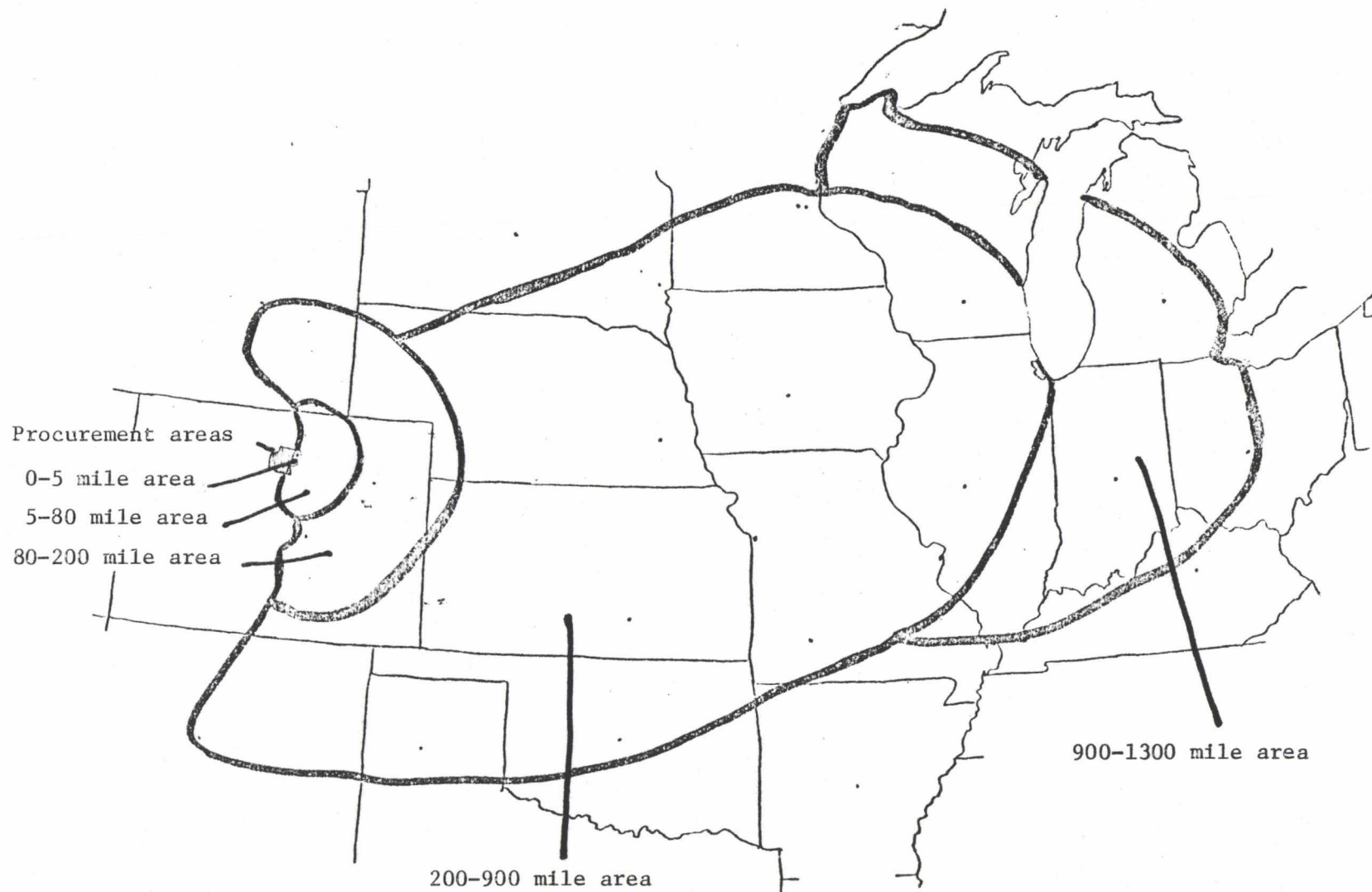


FIGURE II-4 - Transportation Isocost Map and Marketing Area for Boulder-Longmont

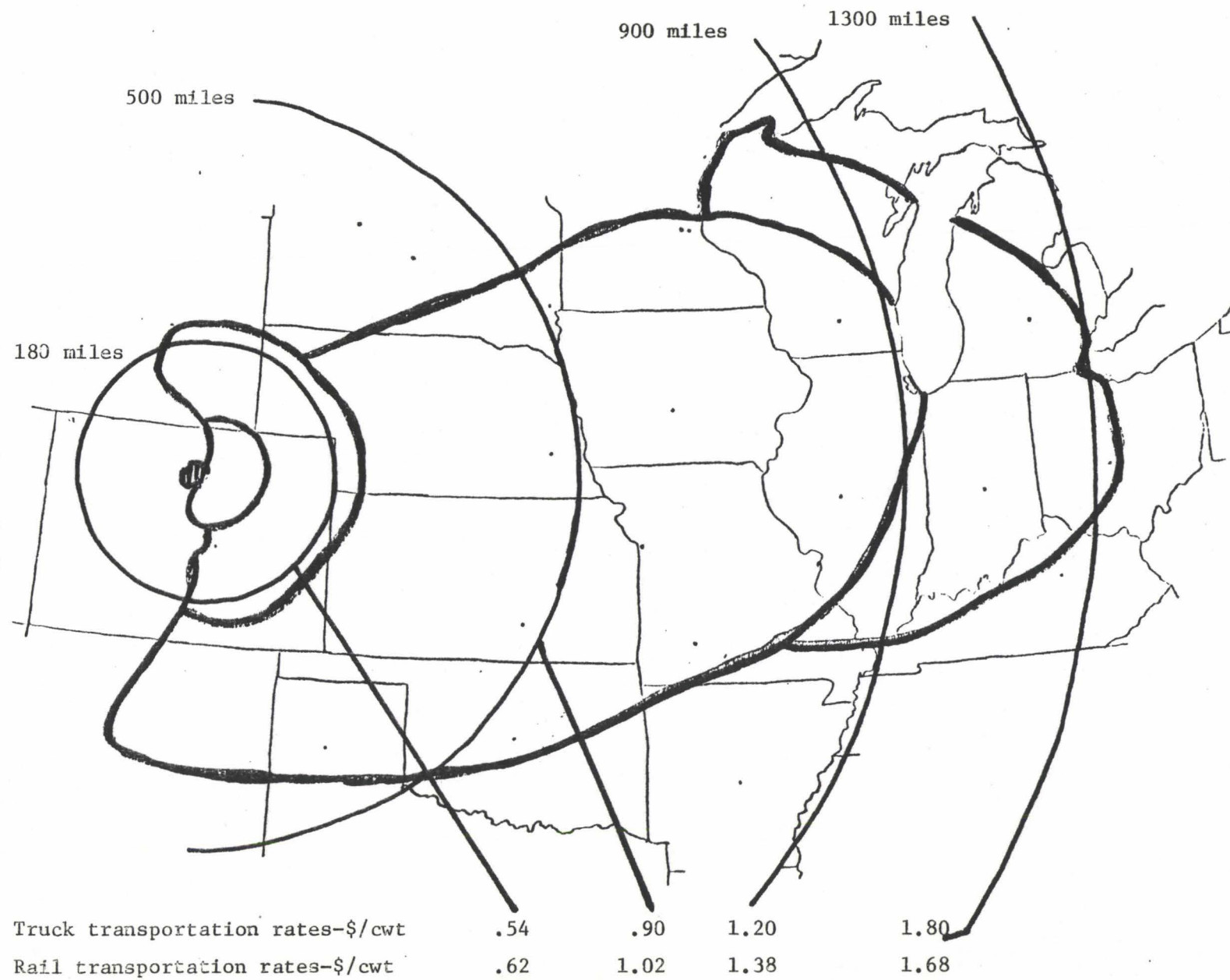


TABLE II-10 - Boulder-Longmont

Raw Material Supply versus Raw Material Consumed

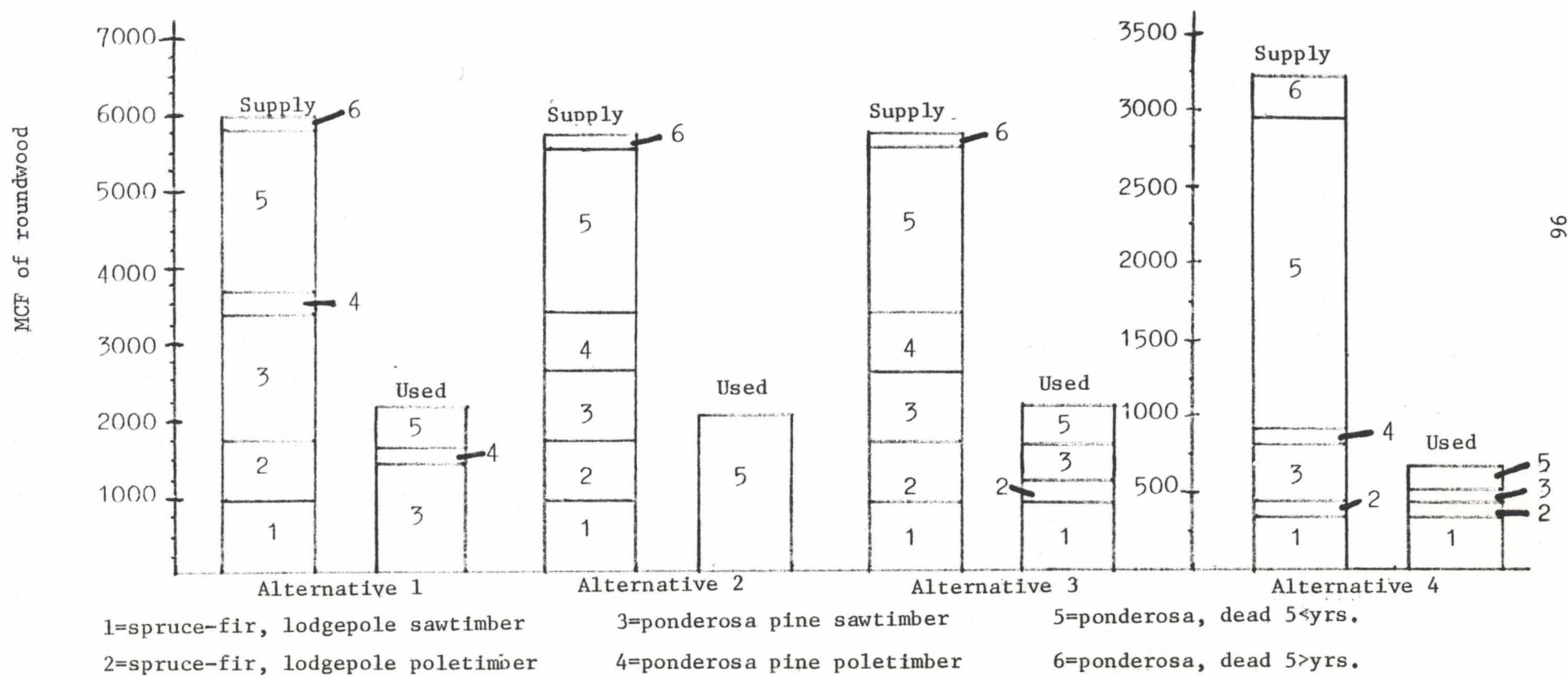


TABLE II-11 - Boulder-Longmont

Market Consumption: Resources to Products (in MCF of roundwood)-No Market Demand Restrictions

	ALT. 1	ALT. 2	ALT. 3	ALT. 4
0-5 mile	boards r(PP) 1134.2	boards r(d<5) 921.9	boards r(PP) 448.0	boards r(PP) 78.2
	boards p(PP) 78.8	boards p(D<5) 64.0	boards r(SL) 686.2	boards r(SL) 216.8
	houselogs (PP) 40.2	houselogs (d<5) 40.2	houselogs (SL) 40.2	houselogs (SL) 26.8
	firewood (d<5) 447.7	firewood (d<5) 447.7	firewood (d<5) 447.7	firewood (d<5) 111.8
	chips 404.7	chips 404.7	chips 404.7	chips 123.3
	sawdust 197.0	sawdust 197.0	sawdust 197.0	sawdust 60.0
	shavings 55.2	shavings 55.2	shavings 55.2	shavings 20.3
5-80 mile	barn p (PP) 112.9	barn p (d<5) 112.9	barn p (SL) 112.9	barn p (SL) 37.8
	corral p (PP) 22.5	corral p (d<5) 22.5	corral p (SL) 22.5	corral p (SL) 7.5
	fence p (PP) 37.2	fence p (d<5) 37.2	fence p (SL) 37.2	fence p (SL) 12.4
	dimension 1 (PP) 117.2	dimension 1 (d<5) 95.3	dimension 1 (SL) 117.2	dimension 1 (SL) 49.8
80- 200 mile	paneling (d<5) 85.3	paneling (d<5) 85.3	paneling (d<5) 85.3	paneling (d<5) 29.9
	railroad t (PP) 97.8	railroad t (d<5) 79.5	railroad t (SL) 97.8	railroad t (SL) 58.6
200- 900 mile			boards p (SL) 78.8	boards p (SL) 27.6

PP=ponderosa pine SL=fir, lodgepole pine d<5=ponderosa pine dead<5 years
 p = posts or poles; planed
 r = rough
 t = ties

TABLE II-12 - Boulder-Longmont

Total Returns Distribution Per Market Zone and Alternative

		0-5 mile area <u>1/</u>	5-80 mile area	.80-200 mile area	200-900 mile area
1	Total returns	\$153,668.83	\$112,018.80	\$161,907.60	\$ 0.0
	Due to live PP	94,615.70	112,018.80	50,660.40	0.0
	Due to dead PP	7,160.40	0.00	111,247.50	0.0
	Due to SF-LP	0.00	0.00	0.00	0.0
2	Total returns	\$128,002.33	\$105,502.70	\$160,636.50	\$ 0.0
	Due to live PP	0.00	0.00	0.00	0.0
	Due to dead PP	76,109.60	105,502.70	160,636.50	0.0
	Due to SF-LP	0.00	0.00	0.00	0.0
3	Total returns	\$154,122.23	\$120,624.20	\$164,157.30	\$34,317.40
	Due to live PP	25,760.00	0.00	0.00	0.00
	Due to dead PP	7,160.40	0.00	111,247.50	0.00
	Due to SF-LP	69,309.10	120,624.20	52,909.80	34,317.40
4	Total returns	\$ 49,140.07	\$ 40,997.10	\$ 70,692.20	\$12,019.80
	Due to live PP	4,496.50	0.00	0.00	0.00
	Due to dead PP	1,788.80	0.00	38,989.60	0.00
	Due to SF-LP	26,768.00	40,997.10	31,702.60	12,019.80

1/ As chips, shavings and sawdust were allocated to the 0-5 mile area in each case alternative, their respective values are included in these total returns (residual) figures.

Table II-13 - Boulder-Longmont

ALT	<u>Returns to Stumpage</u>				TOTAL REVENUE
	REVENUE DUE TO LIVE PP	REVENUE DUE TO DEAD PP	REVENUE DUE TO SF-LP	REVENUE DUE TO MILL RESIDUES	
#1	\$257,294.90	118,407.90	00.0	51,893.10	437,595.90
#2	\$0.0	342,248.80	0.0	51,892.82	394,141.62
#3	\$25,760.00	118,407.90	277,160.50	51,892.82	473,221.22
#4	\$4,496.50	40,778.40	111,487.50	16,086.24	172,848.64

TABLE II-14 - Boulder-Longmont

Mill Marginal Revenues, Marginal Costs, Profit & Risk
and Residual

MR-MC-P+R=R*

MR(WHOLESALE PRICE)

MC(STUMPAGE COSTS + PROCUREMENT COSTS + MILLING COSTS + TRANSPORTATION TO MARKET COSTS)

P+R(10% of MC FOR PROFIT & RISK)

R(RESIDUAL)

*(When R is less than 0 the product is considered uneconomical to market in the marketing area)

KEY

- 1) If there is no symbol in front of the product, it is currently marketed and is considered economical.
- 2) *means the product is - currently marketed and is considered uneconomical. using R value as a guide
- 3) **means the product is not currently marketed, but is considered economical to market.
- 4) ***means the product is not currently marketed, and is considered uneconomical.

- (PP) ponderosa pine
- (LP) lodgepole pine
- (SF) spruce-fir
- (d<5) ponderosa pine that's been dead for five years or less.
- Chips (D) = chips from dead wood
- Chips (G) = chips from green wood

Table II-14 - Boulder-Longmont

<u>0-5 Mile Marketing Area</u>				
<u>PRODUCTS</u>	<u>MR/ (MCF)</u>	<u>MC/ (MCF)</u>	<u>P&R</u>	<u>RESIDUAL/ (MCF)</u>
Boards R(PP)	1800	1532	153	115
Boards R(LP&SF)	1800	1490	149	161
Boards R(D<5)	1800	1556	156	88
Boards P(PP)	3657	2928	293	436
Boards P(LP&SF)	3840	2864	286	690
Boards P(D<5)	3474	2964	296	214
Barn Poles(PP)	3469	2758	276	435
Barn Poles(LP&SF)	3469	2716	272	481
Barn Poles(D<5)	3469	2794	279	396
Corral Poles(PP)	3038	2606	261	171
Corral Poles(LP&SF)	3038	2595	259	184
Corral Poles (D<5)	3038	2612	261	165
Fence Posts(PP)	3721	2476	248	987
Fence Posts(LP&SF)	3721	2465	246	1010
Fence Posts (D<5)	3721	2482	248	991
Houselogs(PP)	1944	1491	149	304
Houselogs(LP&SF)	1944	1449	145	350
Houselogs(D<5)	1744	1527	153	264
Panelling(D<5)	5485	4390	439	656
Dimension L(PP)	2400	2180	218	2
Dimension L(LP&SF)	2400	2138	214	48
*Dimension L(D<5)	2400	2204	220	-24
Firewood (D<5)	588	511	51	26
Firewood (D>5)	588	523	52	13
RR Ties(PP)	3564	2853	285	426
RR Ties(LP&SF)	3564	2811	281	472
RR Ties (D<5)	3564	2877	288	399
Chips (D&G)	125	42	4	79
Shavings	125	42	4	79
Sawdust	125	42	4	79

Table II-14 - Boulder-Longmont (cont)

5-80 Mile Marketing Area

**Boards R(PP)	1740	1566	157	17
**Boards R(LP&SF)	1740	1524	152	64
***Boards R(D<5)	1740	1590	159	-9
Boards P(PP)	3657	2980	298	379
Boards P(LP&SF)	3840	2916	292	632
Boards P(D<5)	3474	3016	302	156
Barn Poles(PP)	3564	2813	281	470
Barn Poles(LP&SF)	3564	2771	277	516
Barn Poles(D<5)	3564	2849	285	430
Corral Poles(PP)	3204	2662	266	276
Corral Poles(LP&SF)	3204	2651	265	288
Corral Poles(D<5)	3204	2668	267	269
Fence Posts(PP)	4069	2532	253	1284
Fence Posts(LP&SF)	4069	2521	252	1296
Fence Posts (D<5)	4069	2538	254	1277
Houselogs(PP)	2004	1548	155	301
Houselogs(LP&SF)	2004	1506	151	347
Houselogs(D<5)	2004	1584	158	262
Panelling(D<5)	6217	4442	444	1331
**Dimension L(PP)	2520	2214	221	85
**Dimension L(LP&SF)	2520	2172	217	131
**Dimension L(D<5)	2520	2238	224	58
***Firewood(D<5)	768	743	74	-49
***Firewood(D>5)	768	755	75	-62
RR Ties(PP)	3564	2914	291	359
RR Ties(LP&SF)	3564	2872	287	405
RR Ties(D<5)	3564	2938	294	332
Chips (G&D)	187	152	15	20
Shavings	187	152	15	20
Sawdust	187	152	15	20

Table II-14 - Boulder-Longmont (cont)

80-200 Mile Marketing Area

Boards P(PP)	3474	3093	309	72
Boards P(LP&SF)	3657	3029	303	325
***Boards P(D<5)	3383	3129	313	-59
Barn Poles (PP)	3408	3046	305	57
Barn Poles(LP&SF)	3408	3004	300	104
Barn Poles(D<5)	3408	3082	308	18
Fence Posts (PP)	4069	2768	277	1024
Fence Posts(LP&SF)	4069	2757	276	1036
Fence Posts(D<5)	4069	2774	277	1018
Houselogs(PP)	1944	1767	176	1
Houselogs(LP&SF)	1944	1725	172	47
*Houselogs(D<5)	1944	1803	180	-39
Panelling(D<5)	7314	4723	472	2119
RR Ties(PP)	4488	3138	314	1036
RR Ties(LP&SF)	4488	3096	310	1082
RR Ties(D<5)	4488	3162	316	1010
***Boards r(All)	-	-	-	-(Very High)
*Corral P(All)	-	-	-	-176
***Dimension(All)	-	-	-	-(Very High)
***Firewood(all)	-	-	-	-(Very High)
***Chips(All)	-	-	-	-(Very High)
***Shavings(All)	-	-	-	-(Very High)
***Sawdust(All)	-	-	-	-(Very High)

Table II-14 - Boulder-Longmont (cont)

200-900 Mile Marketing Area

**Boards P(PP)	3657	3261	326	70
Boards P(LP&SF)	4388	3197	320	871
***Boards P(D<5)	3474	3297	330	-153
**Fence Posts (PP)	4069	3602	360	107
**Fence Posts(LP&SF)	4069	3591	359	119
**Fence Posts (D<5)	4069	3408	361	100
**Panelling(D<5)	7314	4723	472	2119
**RR Ties (PP)	5268	3980	398	890
**RR ties (LP&SF)	5268	3938	394	936
**RR Ties (D<5)	5268	4004	400	864
***Other Products	-	-	-	-(Very High)

900-1300 Mile Marketing Area

***Boards P(PP)	3657	3473	347	-163
**Boards P(LP&SF)	4388	3409	341	638
***Boards P(D<5)	3474	3509	351	-386
**Panelling(D<5)	7314	4935	494	1885
**Chips(G&D)	244	212	21	11
***Other Products	-	-	-	-(Very High)

Table II-15 - Cost Breakdown Sheet for Boulder - Longmont Processing Center

PRODUCTS (FC-L)	STUMPAGE		PROCUREMENT		MILLING		P&R %	TRANSP MCF (0-5)	TRANSP MCF (5-80)	TRANSP MCF (80-200)
	MBF	MCF	MBF	MCF	MBF	MCF				
BoardsR(PP)	3.00	36.00	64.51	774	59.99	720	.10	1.80	36.00	-
Boards R(LP)	4.00	48.00	60.01	720	"	"	"	"	"	-
Boards R(SF)	"	"	"	"	"	"	"	"	"	-
Boards R(D<5)	.50	6.00	69.01	828	"	"	"	"	"	-
Boards P(PP)	3.00	54.85	64.52	1179	92.49	1691	.10	2.74	54.85	167.85
Boards P(LP)	4.00	73.14	60.01	1097	"	"	"	"	"	"
Boards P(SF)	"	"	"	"	"	"	"	"	"	"
Boards P(D<5)	.50	9.14	69.01	12.61	"	"	"	"	"	"
BarnPoles(PP)	2.00	24.00	64.51	774	163.09	1957	.10	3.18	57.97	291.39
BarnPoles(LP)	3.00	36.00	60.01	720	"	"	"	"	"	"
BarnPoles(SF)"	"	"	"	"	"	"	"	"	"	"
BarnPoles (D<5)	.50	6.00	69.01	82.8	"	"	"	"	"	"
CorralPoles (PP)	2.00	24.00	41.37	496	173.60	2083	.10	3.22	58.71	295.14
CorralPoles (LP)	3.00	36.00	39.40	473	"	"	"	"	"	"
CorralPoles (SF)	"	"	"	"	"	"	"	"	"	"
CorralPoles (D<5)	.50	6.00	43.34	520	"	"	"	"	"	"
FencePosts(PP)	2.00	24.00	41.37	496	162.73	1953	.10	3.22	58.71	295.14
FencePosts(LP)	3.00	36.00	39.40	473	"	"	"	"	"	"
FencePosts(SF)"	"	"	"	"	"	"	"	"	"	"
FencePosts (D<5)	.50	6.00	43.34	520	"	"	"	"	"	"
Houselogs(PP)	2.00	24.00	64.51	734	57.49	690	.10	3.20	60.75	279.63
Houselogs(LP)	3.00	36.00	60.01	720	"	"	"	"	"	"
Houselogs(SF)"	"	"	"	"	"	"	"	"	"	"
Houselogs (D<5)	.50	6.00	69.01	828	"	"	"	"	"	"
Panelling (D<5)	.50	9.14	69.01	1261	170.49	3117	.10	2.74	54.85	164.90
Dimension L (PP)	3.00	36.00	64.51	774	114	1368	.10	1.80	36.00	160.0
Dimension L (LP)	4.00	48.00	60.01	720	"	"	"	"	"	"
Dimension L (SF)	"	"	"	"	"	"	"	"	"	"

Table II-15

PRODUCTS (FC-L)	STUMPAGE		PROCUREMENT		MILLING		P&R %	TRANSP		TRANSP MCF (80-200)
	MBF	MCF	MBF	MCF	MBF	MCF		MCF (0-5)	MCF (5-80)	
Dimension L (D<5)	.50	6.00	69.01	828	"	"	"	"	"	"
Firewood (D<5)	.50	6.00	40.58	487	0	0	.10	17.60	250.0	-
Firewood (D>5)	"	"	"	41.58	499	"	"	"	"	-
RRTies(PP)	3.00	36.00	64.51	774	170	2040	.10	3.20	64.10	288.50
RRTies(LP)	4.00	48.00	60.01	720	"	"	"	"	"	"
RRTies(SF)	"	"	"	"	"	"	"	"	"	"
RRTies(D<5)	.50	6.00	69.01	828	"	"	"	"	"	"
Chips(D)	-	-	-	-	3.00	36.00	.10	5.81	116.27	349.00
Chips(G)	-	-	-	-	"	"	"	"	"	"
Shavings	-	-	-	-	3.00	36.00	.10	5.81	116.27	349.00
Sawdust	-	-	-	-	3.00	36.00	.10	5.81	116.29	349.00

(All figures are \$/MBF or \$/MCF as indicated.)

Table II-15 (cont)

PRODUCTS	TRANSP (200-900)		TRANSP (900-1300)		PROD V (0-5)		PROD V (5-80)		PROD V (80-200)		PROD V (200-900)		PROD V (900-1300)	
	MCF		MCF		MBF	MCF	MBF	MCF	MBF	MCF	MBF	MCF	MBF	MCF
Boards R(PP)	-	-	-	-	150	1800	145	1740	150	1800	-	-	-	-
Boards R(LP)	-	-	-	-	"	"	"	"	"	"	-	-	-	-
Boards R(SF)	-	-	-	-	"	"	"	"	"	"	-	-	-	-
Boards R(D<5)	-	-	-	-	"	"	"	"	"	"	-	-	-	-
Boards P(PP)	3.36	548			200	3657	200	3657	190	3474	200	3657	-	-
Boards P(LP)	"	"			210	3840	210	3840	200	3657	240	4388	240	4388
Boards P(SF)	"	"			"	"	"	"	"	"	"	"	-	-
Boards P(D<5)	"	"			190	3474	390	3474	185	3383	190	3474	-	-
BarnPoles(PP)	-	-	-	-	289	3469	297	3564	284	3408	-	-	-	-
BarnPoles(LP)	-	-	-	-	"	"	"	"	"	"	-	-	-	-
BarnPoles(SF)	-	-	-	-	"	"	"	"	"	"	-	-	-	-
BarnPoles(D<5)	-	-	-	-	"	"	"	"	"	"	-	-	-	-
CorralPoles(PP)	-	-	-	-	253	8038	265	3204	251	3012	-	-	-	-
CorralPoles(LP)	-	-	-	-	"	"	"	"	"	"	-	-	-	-
CorralPoles(SF)	-	-	-	-	"	"	"	"	"	"	-	-	-	-
CorralPoles(D<5)	-	-	-	-	"	"	"	"	"	"	-	-	-	-
FencePosts(PP)	1129	-	-	-	310	3721	339	4089	319	4089	339	4069	-	-
FencePosts(LP)	"	-	-	-	"	"	"	"	"	"	"	"	-	-
FencePosts(SF)	"	-	-	-	"	"	"	"	"	"	"	"	-	-
FencePosts(D<5)	"	-	-	-	"	"	"	"	"	"	"	"	-	-
Houselogs(PP)	-	-	-	-	162	1944	167	2004	162	1944	-	-	-	-
Houselogs(LP)	-	-	-	-	"	"	"	"	"	"	-	-	-	-
Houselogs(SF)	-	-	-	-	"	"	"	"	"	"	-	-	-	-
Houselogs(D<5)	-	-	-	-	"	"	"	"	"	"	-	-	-	-
Panelling(D<5)	336	548			300	5485	340	6217	400	7314	400	7314	400	7314
DimensionL(PP)	-	-	-	-	200	2400	210	2520	200	2400	-	-	-	-
DimensionL(LP)	-	-	-	-	"	"	"	"	"	"	-	-	-	-
Dimension(SF)	-	-	-	-	"	"	"	"	"	"	-	-	-	-
Dimension(D<5)	-	-	-	-	"	"	"	"	"	"	-	-	-	-
Firewood(D<5)	-	-	-	-	49	588	64	768	49	588	-	-	-	-
Firewood(D>5)	-	-	-	-	"	"	"	"	"	"	-	-	-	-
RRTies(PP)	1130	2085			297	3564	297	3569	374	4488	439	5268	400	4800
RRTies(LP)	"	"			"	"	"	"	"	"	"	"	"	"
RRTies(SF)	"	"			"	"	"	"	"	"	"	"	"	"
RRTies(D>5)	"	"			"	"	"	"	"	"	"	"	"	"
Chips(D)	-	-	-	-	176.31	-	125	-	187	-	-	-	-	244
Chips(G)	-	-	-	-	"	-	"	-	"	-	-	-	-	"
Shavings	-	-	-	-	-	-	125	-	187	-	-	-	-	-
Sawdust	-	-	-	-	-	-	125	-	187	-	-	-	-	-

PROD V - (product value) refers to marginal revenue from each product in a given market zone.

R = rough P = planed L = lumber

Case Study II: Boulder-Longmont Tributary Area

Summary Analysis

As in the Fort Collins-Loveland study, the purpose of this analysis is to locate favorable mixes of products within each alternative as well as for the case study in its entirety. A sensitivity analysis will consider, as in the Fort Collins case, the impact of a demand limitation on the utilization of raw material, as well as the market zone location of its consumption and overall return.

Raw Material Supply Versus Amount Consumed

Each alternative would yield, through its designated cuts, a raw material supply in excess of the total consumed.

	<u>Alt. 1</u>	<u>Alt. 2</u>	<u>Alt. 3</u>	<u>Alt. 4</u>
Supply-Consumption	3853.2 MCF	3693.4 MCF	3559.2 MCF	2556.5 MCF
Differential				

Thus, as in the Fort Collins-Loveland study, the production capacity would be filled in each alternative with a residual of available raw material. It should be noted here that the proportion of raw material available in the Boulder-Longmont area that is dead less than five years approaches 40% of the total raw material supply in some alternatives and well over 50% in Alternative 4, the current situation. In two of the first three alternatives, approximately one-fourth of the quantity was used. Alternative 2, emphasizing removal of previous year ponderosa pine mortality used nearly the entire amount.

Utilization of All Ponderosa Pine Types

Total ponderosa pine, sawtimber, poletimber, dead<5 years and dead>5 years, used per alternative study compared with total ponderosa pine supply is summarized in the following table:

<u>Alternative</u>	1	2	3	4
PP Supply	4327	4033	4033	2773 MCF
PP Used	2173.8	2039.6	981	220 MCF

Alternative 1 displays a high supply level due to use of a recommended overall ponderosa pine cut in comparison to allowable cut on ponderosa pine sawtimber and poletimber and recommended cuts reserved for mortality and salable types only. A priority goal was one of the factors at work in alternative 1 and 2 which emphasized usage of ponderosa pine, accounting for the comparatively high levels of consumption.

Utilization of Beetle-Killed Ponderosa Pine

As will be noted below, alternative 2 utilized the greatest amount of available dead ponderosa pine supply.

Alternative	1	2	3	4	
Dead Ponderosa Pine Supply	2333	2333	2333	2333	MCF
Dead Ponderosa Pine Used	533	2039.6	533	141.8	MCF

This alternative also realized the greatest return to stumpage of the four, equal to \$342,000, which was 81% of the highest overall revenue of the four alternatives (See Table II-13).

Overall Returns to Stumpage

The table below attempts to derive comparisons between percentages of supply of a material type and percentages of total revenue to which the raw material accrues.

ALTERNATIVE

Ponderosa Pine as a % of Total Supply	71.8	70.3	70.3	86.3
" " Used	100	100	45.1	33.5
Revenue as a % due to PP	87.9	86.8	30.5	26.2
Spruce-fir, Lodgepole as a % of total	28.2	29.7	29.7	13.7
" " Used	0	0	54.9	66.5
Revenue as a % of total	0	0	58.6	64.5
Total Revenue*	427,595.90	394,141.62	473,221.22	172,848.64

*Revenue figure includes revenue due to mill residues

As is seen in both alternatives 1 and 2, ponderosa pine equals 100% of the total supply used as well as revenue realized. These events are due to priority put on the use of ponderosa pine. When this priority is dropped from the model, the percentage of revenue and supply due to ponderosa pine takes a significant drop. This then allows use of spruce-fir, lodgepole pine as a raw material source which yield, in most cases, a higher marginal return. The point to be made here is that regardless of a lower return per MCF of ponderosa pine products, substantial overall profit can be made by its use.

Table II-13 illustrates the point that dead ponderosa pine products can return a significant level of profit to the processing center equal to 75% of the total profit in Alternative 4, the current situation.

The highest total revenue was found in Alternative 3, \$473,221.22, with 30% of this total accruing to ponderosa pine types. This total represents a 274% increase over current condition returns.

General Consumption Breakdown

The consumption of products by market zone follows the general trend below: (when given no demand constraints)

0-5 mile	boards	5-80 mile	barn poles
	housetlogs		corral poles
	firewood		fence posts
	chips		dimension lumber
	shavings		
	sawdust	200-900 mile	boards p (SFLP)
80-200 mile	paneling		
	railroad ties		

Optimum Ponderosa Pine Utilization

Overall, the greatest potential for utilization of ponderosa pine lies in Alternative #1, which also yields the highest return due to live ponderosa pine material. Alternative #2 yields the greatest return due to strictly dead

ponderosa pine material. Thus, for the purpose of maximizing utilization of ponderosa pine overall Alternative #1 would be selected, with Alternative #2 selected for maximizing utilization of dead ponderosa pine material.

Product Profit Potentials

Many products currently produced in the Boulder-Longmont processing center could, according to this study, be economically marketed at distances greater than presently reached. From examination of Table II-15 the following list of potential marketable products was derived:

5-80 mile zone:

<u>Products</u>	<u>Returns to Stumpage (\$/MCF of round wood)</u>
boards r - PP	8.50
boards r - SFLP	32.00
dimension lumber - PP	42.50
dimension lumber - SFLP	65.50
dimension lumber - D<5	29.00

200-900 mile zone:

<u>Products</u>	<u>Returns to Stumpage (\$/MCF of round wood)</u>
boards p. - PP	36.00
fence posts - SFLP	1036.00
fence posts - D<5	1018.00
paneling - D<5	1303.50
railroad ties - SFLP	541.00
railroad ties - PP	518.00
railroad ties - D<5	505.00

900-1300 mile zone:

<u>Products</u>	<u>Returns to Stumpage (\$/MCF of round wood)</u>
boards p. - SFLP	319.00
paneling - D<5	1159.50
chips	11.00

SFLP= spruce-fir, lodgepole
D<5= ponderosa pine, dead<5 years

PP= ponderosa pine

Boulder-Longmont Tributary Area

Sensitivity Analysis

The supply of raw material available far exceeded the consumption level of each alternative in the sensitivity analysis as it had in the original alternative goal program runs. The levels of resources used are presented below for both the sensitivity as well as the original alternatives of the Boulder-Longmont area.

ALTERNATIVES	<u>Resources Used (MCF of roundwood)</u>				
	1	2	3	4	
ORIGINAL ANALYSIS	2173	2039	2173	656	MCF
SENSITIVITY ANALYSIS	1770	1827	1738	555.8	MCF

This drop in raw material consumed reflects the impact of the demand limitation in the first market zone on the total level of consumption. For the 0-5 mile area, firewood was originally consumed at a level of 448 MCF. In the sensitivity run the consumption level was cut to 44 MCF based on the demand limitation. Using the marginal analysis, firewood is found to be uneconomical to market beyond the first zone. The remaining 404 MCF of firewood capacity was forfeited (see Table II-11). In regard to most products, the production above the 10% marketed in the first zone, was consumed, if possible, in the next most economical zone.

Table II-16 - Boulder-Longmont: SENSITIVITY STUDY

Raw Material Supplies Versus Raw Material Used

Alternative 1

Supply(MCF of roundwood)			Resources Used(MCF of roundwood)
SFLP	sawtimber	980.0	0.0
SFLP	poletimber	920.0	0.0
PP	sawtimber	1634.0	1428.0
PP	poletimber	360.0	212.8
PP	dead<5 yrs	2098.0	130.0
PP	dead>5 yrs	<u>275.0</u>	<u>0.0</u>
TOTAL			6027.0 MCF
			1770.8 MCF

Alternative 2

Supply(MCF of roundwood)			Resources Used(MCF of roundwood)
SFLP	sawtimber	980.0	980.0
SFLP	poletimber	720.0	0.0
PP	sawtimber	980.0	40.8
PP	poletimber	720.0	0.0
PP	dead 5<yrs	2058.0	806.9
PP	dead 5>yrs	<u>275.0</u>	<u>0.0</u>
TOTAL			5733.0 MCF
			1827.7 MCF

Alternative 3

Supply(MCF of roundwood)			Resources Used(MCF of roundwood)
SFLP	sawtimber	980.0	980.0
SFLP	poletimber	720.0	212.8
PP	sawtimber	980.0	448.0
PP	poletimber	720.0	0.0
PP	dead<5 yrs	2058.0	97.5
PP	dead>5 yrs	<u>275.0</u>	<u>0.0</u>
TOTAL			5733.0 MCF
			1738.3 MCF

Alternative 4

Supply (MCF of roundwood)			Resources Used(MCF of roundwood)
SFLP	sawtimber	352.0	352.0
SFLP	poletimber	88.0	84.5
PP	sawtimber	352.0	78.2
PP	poletimber	88.0	0.0
PP	dead 5<yrs	2058.0	41.1
PP	dead 5>yrs	<u>275.0</u>	<u>0.0</u>
TOTAL			3213.0 MCF
			555.8 MCF

The following table summarizes by raw material type, the difference in consumption level between the original alternative runs and the sensitivity runs.

Raw Material Used: Original Alternative Minus

Sensitivity Analysis (MCF of roundwood)

	ALT 1-ALT 1-S	ALT 2-ALT 2-S	ALT3-ALT3-S	ALT4-ALT4-S
SFLP sawtimber	0.0	-980.0	0.0	0.0
SFLP poletimber	0.0	0.0	0.0	0.0
PP sawtimber	0.0	- 40.8	0.0	0.0
PP poletimber	0.0	0.0	0.0	0.0
PP dead<5 yr	403.0	1232.7	435.0	100.7
PP dead>5 yr	0.0	0.0	0.0	0.0

Based on a lower level of product consumption and a shifting of portions of product production to less economical marketing zones, the returns to stumpage for each alternative are less in the sensitivity analysis as compared to the original alternatives.

Difference in Returns to Stumpage: Original Alternatives Minus Sensitivity Analysis

	0-5 Miles	5-80 Miles	80-200 Miles	200-900 Miles	Total Difference
ALT1-ALT1-S	\$91,624	-33,028	0.0	0.0	58,596
ALT2-ALT2-S	\$68,514	-46,729	0.0	0.0	21,785
ALT3-ALT3-S	\$90,976	-37,056	2,250	0.0	56,170
ALT4-ALT4-S	\$29,563	-16,385	1,348	0.0	14,526

In some zones, as indicated in the table, the new level of returns to stumpage shows a positive gain over the original alternative results. Due to the limitation constraint, the level of ponderosa pine sawtimber used in alternative 1-S in the 0-5 mile area was 113 MCF in the form of rough boards as compared to 1134 MCF in the original. The remaining 1020 MCF was consumed in the second zone, 5080 miles, resulting in a greater return to stumpage in this zone

than in the original first alternative. However, in both cases the same amount of ponderosa pine sawtimber was consumed.

In the second alternative, as shown above, 980 more units of spruce-fir, lodgepole pine raw material were used in the sensitivity analysis than the original run. This, as with the ponderosa pine, was consumed in the 5-80 mile zone as a net increase in returns there.

Overall, the highest returns to stumpage were derived in the initial case study runs as the lack of demand constraint allowed the profit maximization goal to operate without restriction.

Demand limitation in the 0-5 mile market area resulted in a change in the pattern of consumption and the level of that consumption, as shown in Table II-20. In comparison with Table II-11, the shifts suggested above may be observed as a general indication of the sensitivity consumption pattern compared to the original alternatives.

General Product Consumption Breakdown

<u>ORIGINAL ALTERNATIVES/SENSITIVITY</u>			<u>ORIGINAL ALTERNATIVES/SENSITIVITY</u>		
0-5 mile zone	Boards	boards	80-200 mile zone	panelling	panelling
	housetlogs	housetlogs		railroad	railroad
	firewood	firewood		ties	ties
	chips	chips	200-900 mile zone	boards	boards
	shavings	shavings		planed	planed
	sawdust	sawdust			
5-80 mile zone	barn poles	barn poles			
	corral poles	corral poles			
	fence posts	fence posts			
	dimension	dimension			
	lumber	lumber			
		boards			
		housetlogs			

TABLE II-17 - Boulder-Longmont: SENSITIVITY STUDY

Raw Material Supply versus Raw Material Consumed

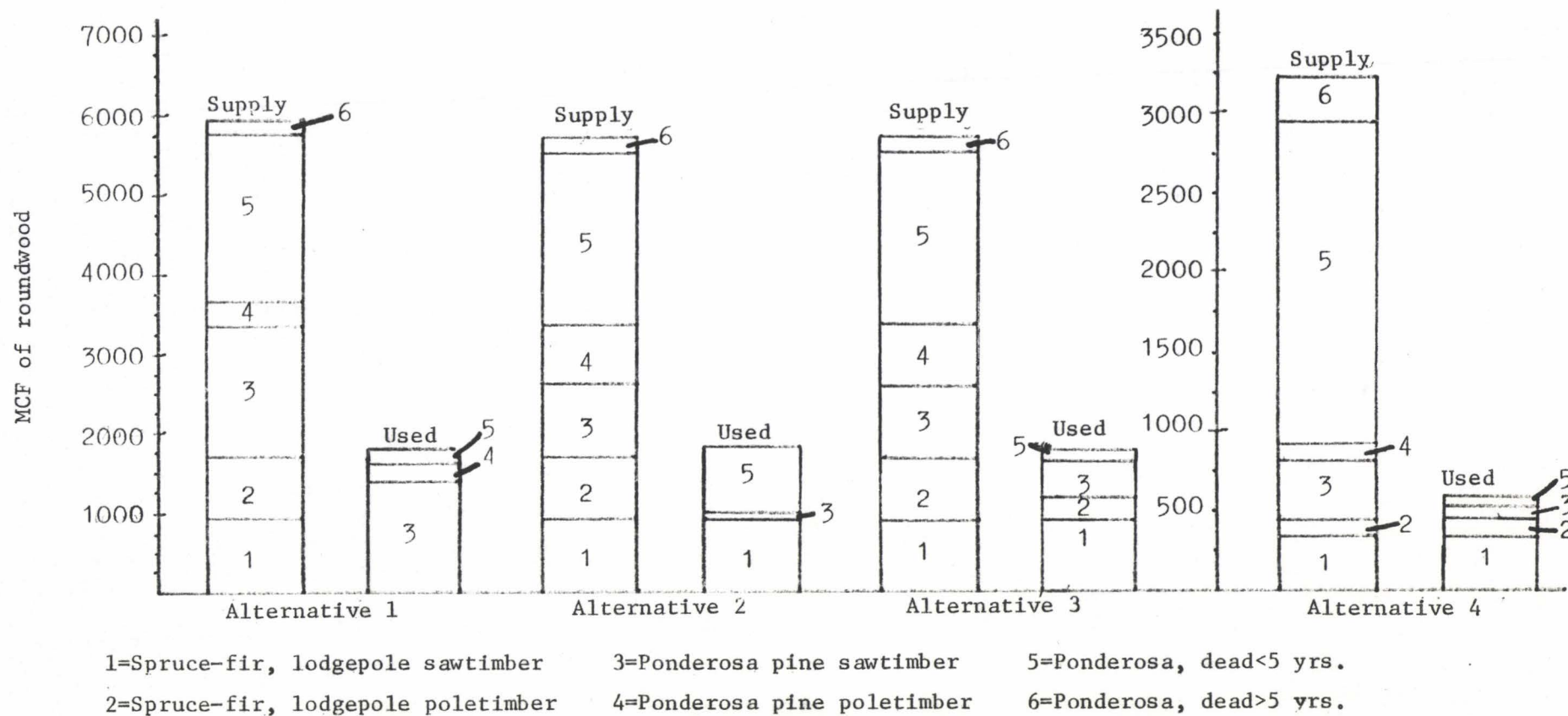


Table II-18 - Boulder-Longmont: SENSITIVITY STUDY

Total Returns Distribution Per Market Zone and Alternative

		0-5 mile zone	5-80 mile zone	80-200 mile zone	200-900 mile zone
ALT 1	total returns	\$62,044.72*	\$145,046.30	\$161,907.90	0.00
	due to PP live	9,436.90	145,046.30	50,660.40	0.00
	due to PP dead	715.00	0.00	111,247.50	0.00
	due to SFLP	0.00	0.00	0.00	0.00
ALT 2	total returns	\$59,488.02*	\$152,231.90	\$160,636.50	0.00
	due to PP live	0.00	346.80	0.00	0.00
	due to PP dead	7,595.20	120,525.10	160,636.50	0.00
	due to SFLP	0.00	31,360.00	0.00	0.00
ALT 3	total returns	\$63,136.52*	\$157,680.10	\$161,907.90	\$34,317.40
	due to PP live	0.00	6,961.50	50,660.40	0.00
	due to PP dead	715.00	0.00	111,247.50	0.00
	due to SFLP	10,528.70	150,718.60	0.00	34,317.90
ALT 4	total returns	\$19,577.34*	\$57,382.60	\$69,344.40	\$12,019.80
	due to PP live	0.00	833.00	30,354.80	0.00
	due to PP dead	179.40	0.00	38,989.60	0.00
	due to SFLP	3,311.70	56,549.60	0.00	12,019.80

TABLE II-19 - Boulder-Longmont: SENSITIVITY STUDY

RETURNS TO STUMPAGE

	revenue due to Ponderosa pine	revenue due to dead Ponderosa pine	revenues due to spruce-fir lodgepole	revenues due to mill residues	Total Revenue
Alternative					
1	\$205,143.60	111,962.50	0.00	51,892.82	\$368,998.92
2	\$346.80	288,756.80	31,360.00	51,892.82	\$372,356.42
3	\$57,621.90	111,962.50	195,564.70	51,892.82	\$417,041.92
4	\$31,187.80	39,169.00	71,881.10	16,086.24	\$158,324.14

Table II-20 - Boulder-Longmont: SENSITIVITY STUDY

Market Consumption: Resources to Products(MCF of roundwood)

	alternative 1		alternative 2		alternative 3		alternative 4	
0-5 mile zone	boardsR(PP)	113.4	boardsR(D<5)	92.2	boardsR(SFLP)	113.4	boardsR(SFLP)	29.4
	boardsP(PP)	7.8	boardsP(D>5)	6.3				
	housetlogs(PP)	4.0	housetlogs(D<5)	6.5				
	firewood(D<5)	44.7	firewood(D<5)	44.7	housetlogs(SFLP)	4.0	housetlogs(SFLP)	2.7
	chips*	404.71	chips*	404.71	firewood(D<5)	44.7	firewood(D 5)	11.2
	sawdust	196.99	sawdust	196.99	chips*	404.71	chips*	123.29
	shavings	55.17	shavings	55.17	sawdust	196.99	sawdust	60.01
					shavings	55.17	shavings	20.33
5-80 mile zone	boardsR(PP)	1020.8	boardsR(PP)	40.8	boardsR(PP)	787.8		
			boards(SFLP)	980.0	boardsR(SFLP)	233.0	boardsR(SFLP)	264.8
	boardsP(PP)	71.0	boardsP(D<5)	59.7				
	housetlogs(PP)	36.2	housetlogs(D<5)	58.8				
					housetlogs(SFLP)	36.2	housetlogs(SFLP)	24.1
	barn P(PP)	112.9	barn P(D<5)	183.5				
					barn P(SFLP)	112.9	barn P(SFLP)	37.8
	corralP(PP)	22.5	corralP(D<5)	36.6	corral P(SFLP)	22.5	corral P(SFLP)	7.5
	fence P(PP)	37.2	fence P(D<5)	60.5	fence P(SFLP)	37.2	fence P(SFLP)	12.4
	dimension(PP)	117.2	dimension(D<5)	95.3	dimension(PP)	117.2	dimension(PP)	19.6
80-200 mile zone	panelling(D<5)	85.3	panelling(D<5)	85.3	panelling(D<5)	83.5	panelling(D<5)	29.9
	RRties(PP)	97.8	RRties(D<5)	79.5	RRties(PP)	97.8	RRties(PP)	58.6
200-900 mile zone					boardsP(SFLP)	78.8	boardsP(SFLP)	27.6

*Mill residues/value is in terms of product, not roundwood

CASE STUDY III: Denver and Suburbs Case Study

The Denver and Suburbs Case Study has a timber procurement base of over 730,000 acres. This procurement acreage was developed in CSU Report #2192. As detailed earlier in this report, the procurement area encompasses areas of present or potential supply for area mills. To avoid the complexity of overlapping procurement areas between processing centers, the center holding a competitive advantage was considered to be the sole timber buying center. The Denver and Suburbs procurement area encompasses private and state land in Clear Creek County and portions of Grand and Jefferson Counties, as well as part of the Arapahoe National Forest. Figure III-1 illustrates as a percentage, the ownership portions encompassing the procurement area as well as accessible acreage within these areas. Table III-1 lists acreage totals for each ownership.

The timber supply in terms of allowable cut, current cut, and recommended annual cut were obtained from CSU Project #2192. The raw material supply, as displayed in Table III-2 illustrates the cut determinations.

The four alternatives for this case study will display the individual input values to represent the four sets of overriding goals. The configurations would represent types and levels of timber cut per species and mill capacities for various products with a standard profit per product for all subsequent alternatives, designed in such a way as to implement the goals.

Production capability is shown in Table III-3 with Table III-4 displaying current annual production for area mills. A definition of the products produced in the Denver and Suburbs center and their respective conversion factors is shown in Table III-5. This table displays the products standard finished size, the amount of wood per product, and in appropriate cases a

conversion from cubic feet of products to board feet.

The results of implementing each alternative are individually briefed in Tables III-6 through III-9. The tables show the constraints and goals for each goal program run. Raw material supply as well as product capacity, reflective of the above constraints, are also shown.

Resources used from different material classes are also displayed adjacent to raw material available in the form of percentages in Table III-10. Thus, examining output strictly in terms of supply, the observer may determine the impact of a certain alternative strategy on the consumption of a certain size and species class of timber relative the others.

The total amount of each material class is broken down into ultimate products in Table III-11. The total profit due to the allocation of raw materials to given products is illustrated in Table III-12. The table sums values for given numbers of products sold in a market area by raw material class. The material classes here are grouped into ponderosa pine live which includes sawtimber and poletimber, ponderosa pine dead which includes dead 5 years and spruce-fir and lodgepole materials grouped.

Table III-13, returns to stumpage, shows the total residual value distribution in each alternative by material class, enabling the observer to quickly note what amount, for example, of a total residual is due to dead and beetle-killed ponderosa pine products.

FIGURE III-1 - Denver and Suburbs Tributary Area

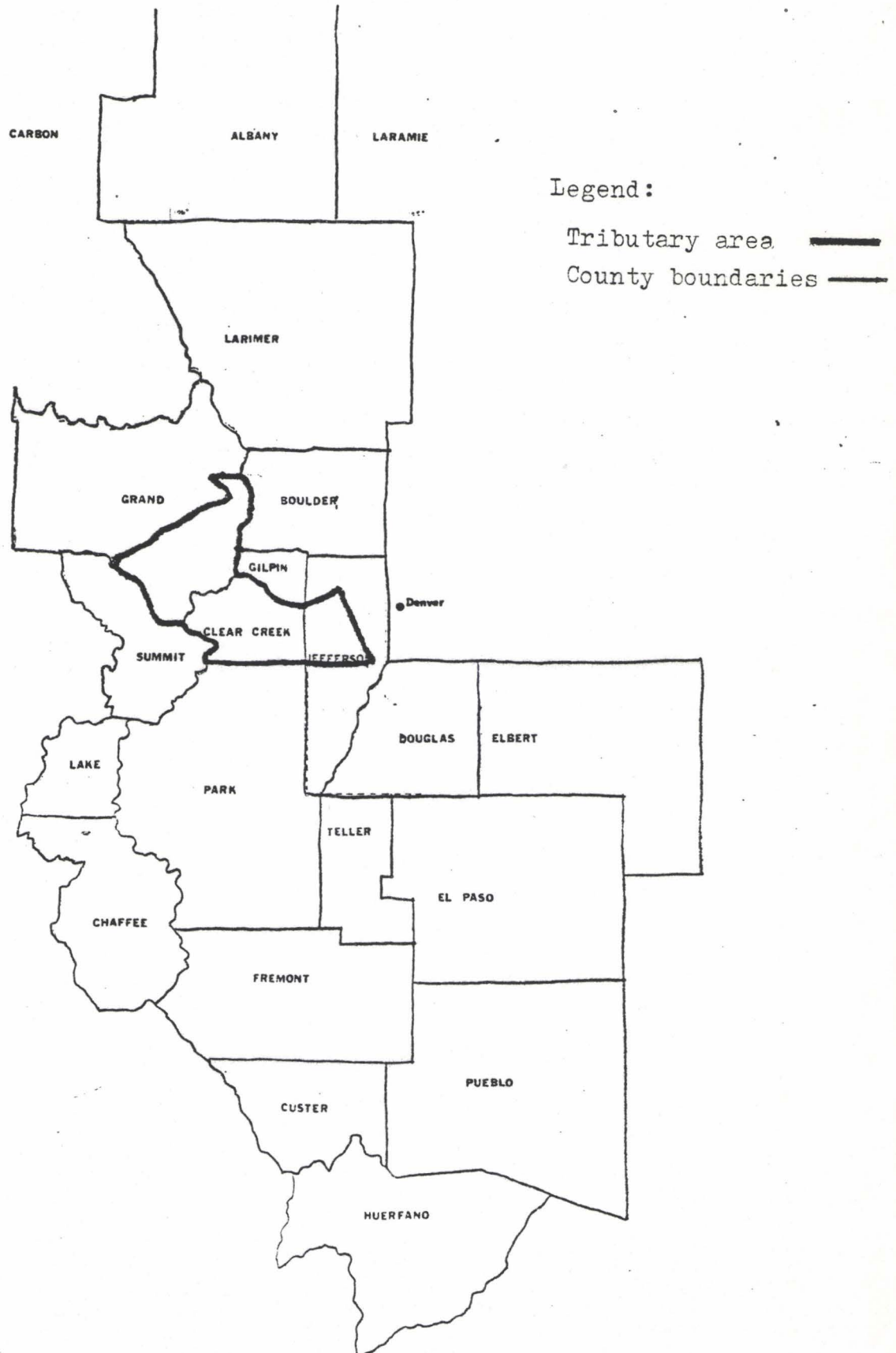


FIGURE III-2: Denver and Suburbs

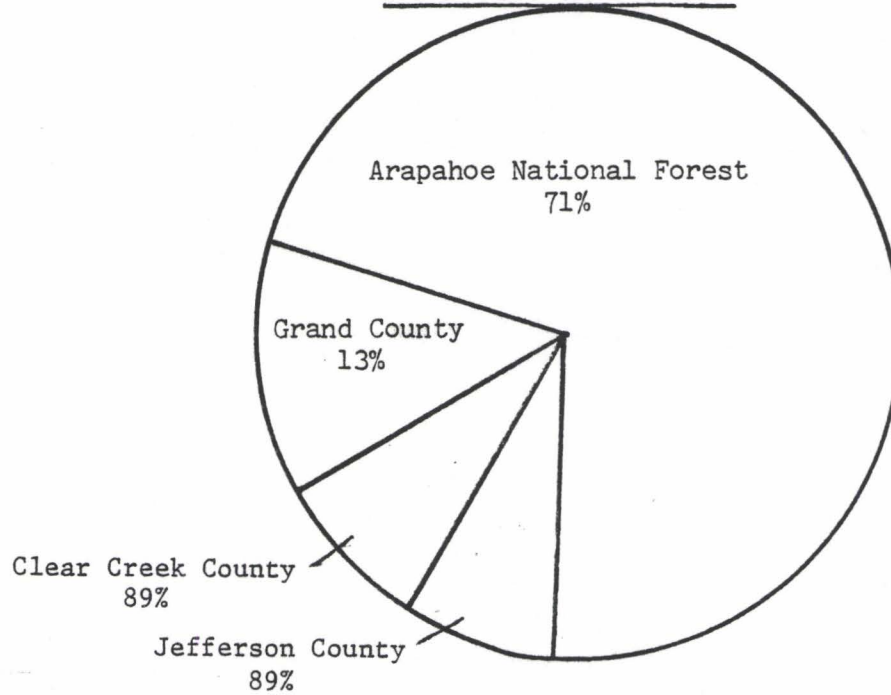
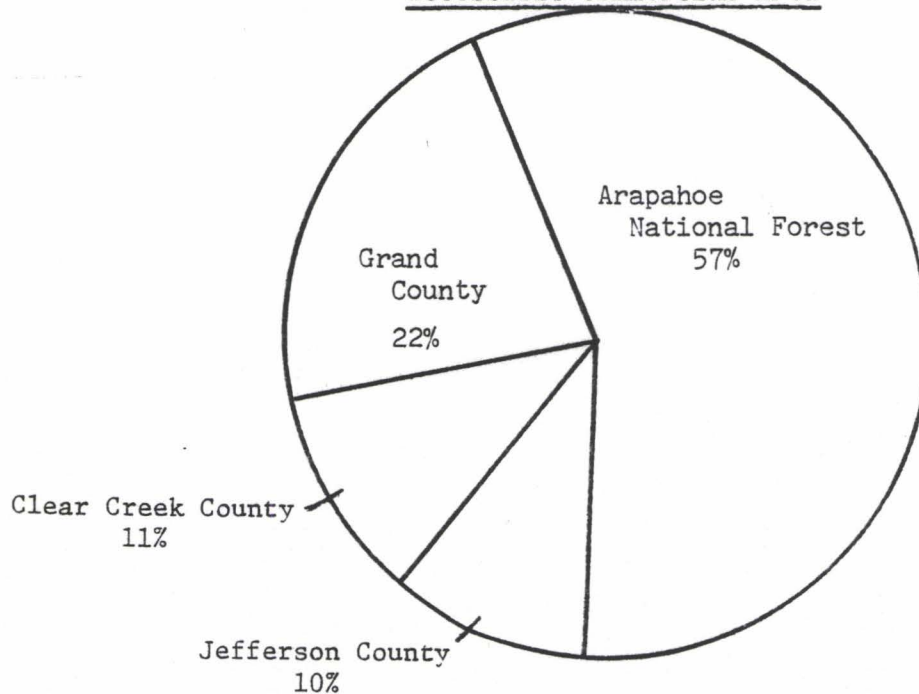
Timber Procurement AreaTotal Procurement AreaAccessible Commercial Area

TABLE III-1 - Denver and Suburbs

Timber Procurement AreaPROCUREMENT AREA:

Arapahoe National Forest:	524,400 Acres
Grand County (state and private):	92,600
Clear Creek (state and private):	57,000
Jefferson County (state and private):	<u>59,750</u>
TOTAL:	733,750 Acres
(forested acres, at least 10% stocked)	

ACCESSIBLE COMMERCIAL FOREST LANDS - PROCUREMENT AREA: 1/

Arapahoe National Forest:	218,480 Acres
Grand County (state and private):	84,100
Clear Creek County (state and private):	43,400
Jefferson County (state and private):	<u>40,484</u>
TOTAL:	386,828 Acres

1/ Standard and special component areas on national forest land,
all state and private lands.

TABLE III-2 - Denver and Suburbs

Raw Material SupplyAllowable Cut

Species	Size Class	bdft/cuft	Allowable	bdft/cuft	Products
Spruce-fir	Sawtimber	5/1	849 MCF	10/1	425 MCF
Spruce-fir	Poletimber	5/1	482	5/1	482
Lodgepole	Sawtimber	5/1	2,377	10/1	1,188
Lodgepole	Poletimber	5/1	1,349	5/1	1,349
Ponderosa Pine	Sawtimber	5/1	339	10/1	169
Ponderosa Pine	Poletimber	5/1	193	5/1	193

Current Cut

Species	Size Class	bdft/cuft	Current	bdft/cuft	Products
Spruce-fir	Sawtimber	5/1	236 MCF	10/1	118 MCF
Spruce-fir	Poletimber	5/1	59	5/1	59
Lodgepole	Sawtimber	5/1	662	10/1	331
Lodgepole	Poletimber	5/1	165	5/1	165
Ponderosa Pine	Sawtimber	5/1	95	10/1	47
Ponderosa Pine	Poletimber	5/1	24	5/1	24

Recommended Cut

Species	Size Class	bdft/cuft	Recommended	bdft/cuft	Products
Ponderosa Pine	Sawtimber	5/1	613 MCF	10/1	306 MCF
Ponderosa Pine	Poletimber	5/1	136	5/1	136
P.P. dead trees (dead < 5 yrs)		5/1	84	8/1	52
P.P. salable dead (dead > 5 yrs)		5/1	612	5/1	612

TABLE III-3 - Denver and Suburbs

Maximum Mill Production Capacity ^{1/}

<u>Product</u>	<u>Output Capacity (product)</u>	<u>Output Capacity (roundwood)</u>
Pallets	97.8 MCF	195.6 MCF
Timbers	48.9	97.8
Rough Boards	87.9	175.8
Planed Boards	78.7	157.8
Utility Poles	95.5	191.0
Houselogs	334.8	334.8
Barn Poles	178.7	178.7
Corral Poles	9.4	9.4
Fence Posts	123.8	123.8
Fencing	29.3	58.6
Firewood	612.0	988.6
Railroad ties	146.6	293.2
Beams	39.4	78.8
Chips	206.4	
Sawdust	100.8	
Shavings	125.2	

^{1/} Based on an 8 hour day, 240 days/yr.

TABLE III-4 - Denver and Suburbs
Current Annual Product Production

<u>Products</u>	<u>Output (product)</u>	<u>Output (roundwood)</u>
Pallets	58.6 MCF	117.2 MCF
Timbers	36.7	73.4
Rough Boards	29.3	58.6
Planed Boards	26.2	52.4
Utility Poles	71.4	142.8
Houselogs	254.4	254.4
Barn Poles	134.5	134.5
Corral Poles	7.1	7.1
Fence Posts	92.8	92.8
Fencing	9.8	19.6
Firewood	153.0	247.2
Railroad Ties	114.9	229.8
Beams	13.1	26.2
Chips	162.5	
Sawdust	79.4	
Shavings	76.2	

TABLE III-5 - Denver and Suburbs

Product Definition and Conversion Factors

Pallets	4' x 4'	20 bdft/pallet		81.47 cuft/MBF
Timbers	6" x 6" x 8'	Treated		81.47 cuft/MBF
Rough Boards	1" x 4"			81.47 cuft/MBF
Planed Boards (P)	1" x 4"			54.69 cuft/MBF
Utility Poles	8" x 12'	4.189 cuft/pole	Treated	
Houselogs	8" x 16"	5.58 cuft/houselog	Tongue and grooved, planed	
Barn Poles	6" x 20'	3.92 cuft/pole	Treated	
Corral Poles	3.0" x 16'	.78 cuft/pole	Treated	
Fence Posts	3.5" x 6.5'	.43 cuft/post	Treated	
Fencing	3" x 1" x 6'	.16 cuft/fence		81.47 cuft/MBF
Firewood	4' x 4' x 8'	85 cuft/cord		
Railroad Ties	6" x 4" x 6'	1 cuft/tie		81.47 cuft/MBF
Beams	4" x 4" x 16'	1.76 cuft/beam		54.69 cuft/MBF
Chips	43 cuft/MBF, 25 lbs/cuft			
Sawdust	21 cuft/MBF			
Shavings	16 cuft/MBF			

TABLE III-6 - Denver and Suburbs

Alternative #1 Description

Constraints: - Annual allowable cut on SF, LP
 - Recommended PP cut
 - Recommended annual cut on mortality PP and salable dead
 - Product capacity for each product

Goals: #1 - minimize underachievement of recommended PP cuts
 #2 - maximization of returns to stumpage

Raw Material Supply (MCF of roundwood):

SF-LP	Sawtimber	3226.0
SF-LP	Poletimber	1831.0
PP	Sawtimber	612.0
PP	Poletimber	136.0
PP	Dead <5 yrs.	84.0
PP	Dead >5 yrs.	612.0
	TOTAL:	6501.0

Resources Used (MCF of roundwood):

587.4
510.7
612.0
136.0
84.0
584.4
2514.5

Maximum Mill Production Capacity (MCF of roundwood):

Pallets	195.6	Fence posts	123.8
Timbers	97.8	Fencing	58.6
Rough Boards	175.8	Firewood	988.6
Planed Boards	157.8	Railroad Ties	293.2
Utility Poles	191.0	Beams	78.8
Houselogs	334.8		
Barn Poles	178.7		
Corral Poles	9.4		

SF-LP = spruce-fir, lodgepole pine

PP = ponderosa pine

TABLE III-7 - Denver and Suburbs

Alternative #2 Description

Constraints: - Annual allowable cut on SF, LP, PP
 - Recommended annual cuts on mortality and salable dead

Goals: #1 - minimize underachievement of removing previous
 year PP mortality
 #2 - maximization of returns to stumpage

Raw Material Supply (MCF of roundwood):

SF-LP	Sawtimber	3226.0
SF-LP	Poletimber	1831.0
PP	Sawtimber	338.0
PP	Poletimber	193.0
PP	Dead <5 yrs.	84.0
PP	Dead >5 yrs.	612.0
	TOTAL:	<u>6284.0</u>

Resources Used (MCF of roundwood):

1150.4
643.6
0.0
0.0
84.0
<u>612.0</u>
<u>2490.0</u>

Maximum Mill Production Capacity (MCF of roundwood):

Pallets	195.6	Fencing	58.6
Timbers	97.8	Firewood	988.6
Rough Boards	175.8	Railroad Ties	293.2
Planed Boards	157.8	Beams	78.8
Utility Poles	191.0		
Houselogs	334.8		
Barn Poles	178.7		
Corral Poles	9.4		
Fence Posts	123.8		

TABLE III-8 - Denver and Suburbs

Alternative #3 Description

Constraints: - Annual allowable cuts on SF, LP, PP
 - Recommended annual cut on mortality PP and salable dead

Goals: #1 - maximization of returns to stumpage

Raw Material Supply (MCF of roundwood):

SF-LP	Sawtimber	3226.0
SF-LP	Poletimber	1831.0
PP	Sawtimber	338.0
PP	Poletimber	193.0
PP	Dead <5 yrs.	84.0
PP	Dead >5 yrs.	612.0
	TOTAL:	6284.0

Resources Used (MCF of roundwood):

1169.4
646.7
0.0
0.0
84.0
599.4
2499.5

Maximum Mill Production Capacity (MCF of product):

Pallets	195.6	Firewood	988.6
Timbers	97.8	Railroad Ties	293.2
Rough Boards	175.8	Beams	78.8
Planed Boards	157.8	(Beams from	
Utility Poles	191.0	dead < 5)	64.0
Houselogs	334.8		
Barn Poles	178.7		
Corral Poles	9.4		
Fence Posts	123.8		
Fencing	58.6		

TABLE III-9 - Denver and Suburbs

Alternative #4 Description

Constraints: - Current cut level for LP, SF, live PP
 - Recommended annual cut for mortality PP and salable dead
 - Current annual production levels for each product

Goals: #1 - maximization of returns to stumpage

Raw Material Supply (MCF of roundwood):

SF-LP	Sawtimber	989.0
SF-LP	Poletimber	224.0
PP	Sawtimber	95.0
PP	Poletimber	24.0
PP	Dead <5 yrs.	84.0
PP	Dead >5 yrs.	612.0
TOTAL:		<u>2028.0</u>

Resources Used (MCF of roundwood):

298.0
224.0
94.0
24.0
84.0
<u>153.0</u>
<u>877.0</u>

Current Mill Production (MCF of roundwood):

Pallets	117.2
Timbers	73.4
Rough Boards	58.6
Planed Boards	52.4
Utility Poles	142.8
Houselogs	254.4
Barn Poles	134.5
Corral Poles	7.1
Fence Posts	92.8
Fencing	19.6
Firewood	247.2

Railroad Ties	229.8
Beams	26.2

TABLE III-10 - Denver and Suburbs

Raw Material Supply versus Raw Material Used

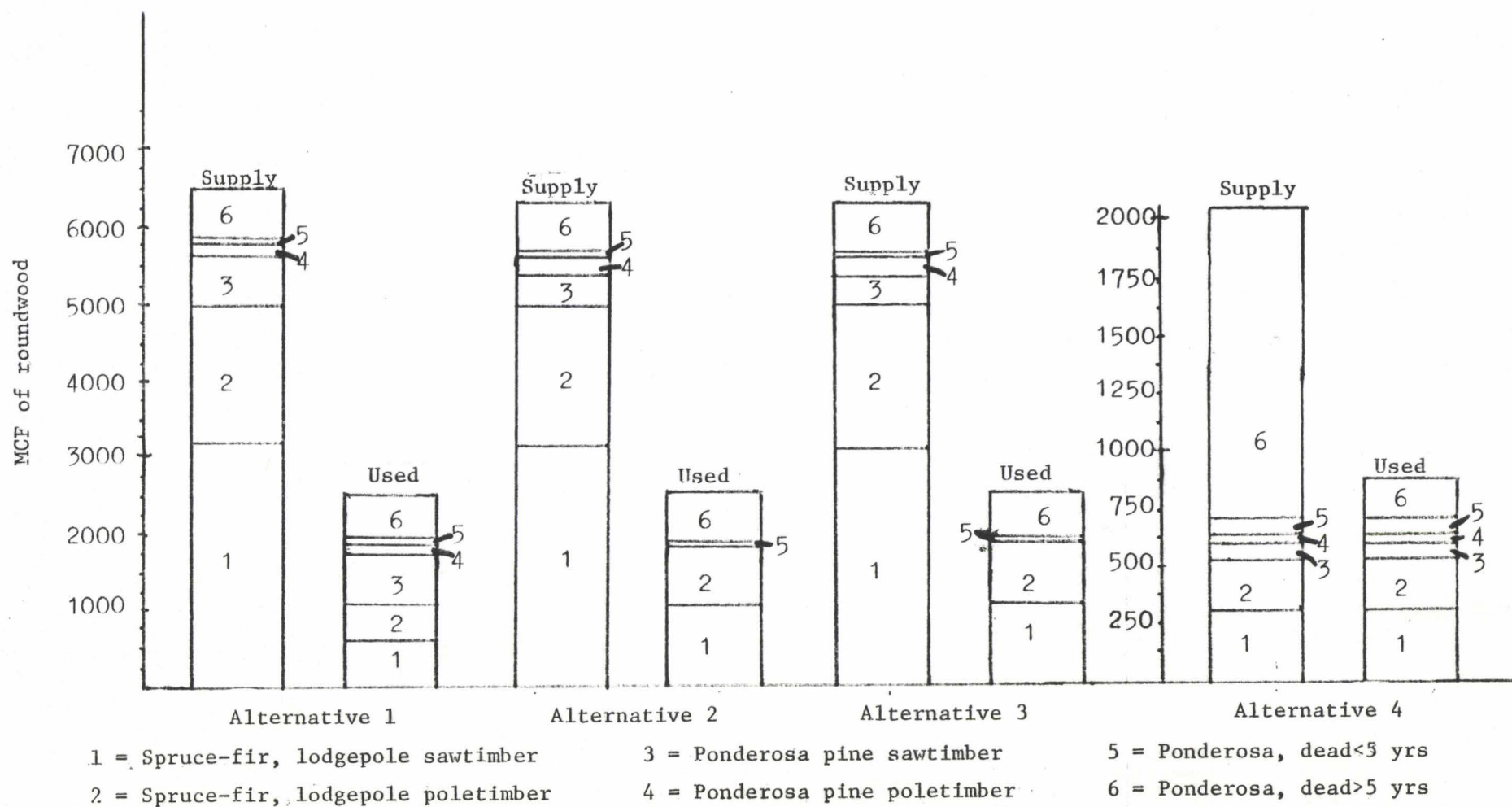


Figure III-3 - Market Area for Denver and Suburbs Processing Center

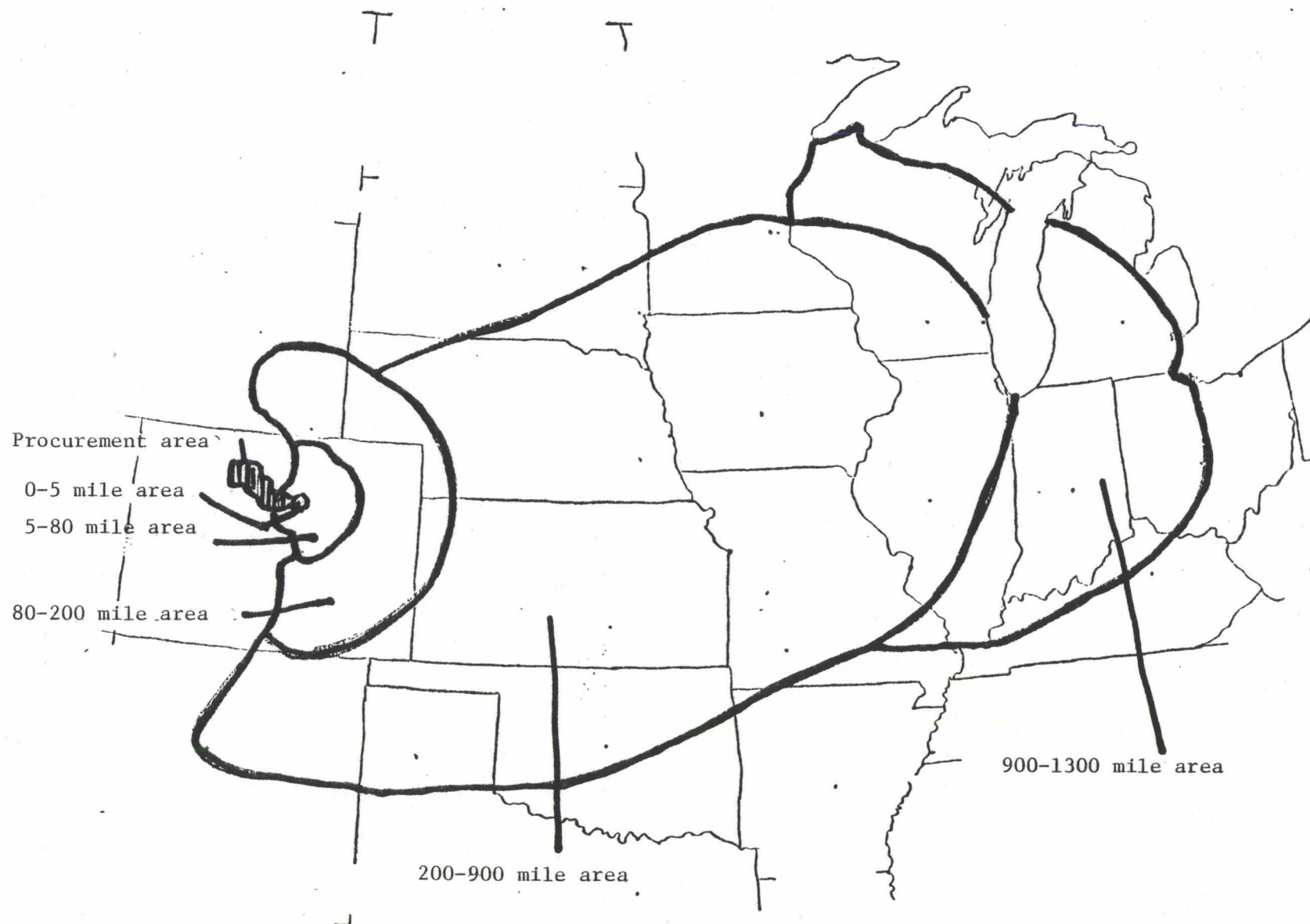


Figure III-4 - Transportation Isocost Map and Marketing Area for Denver and Suburbs

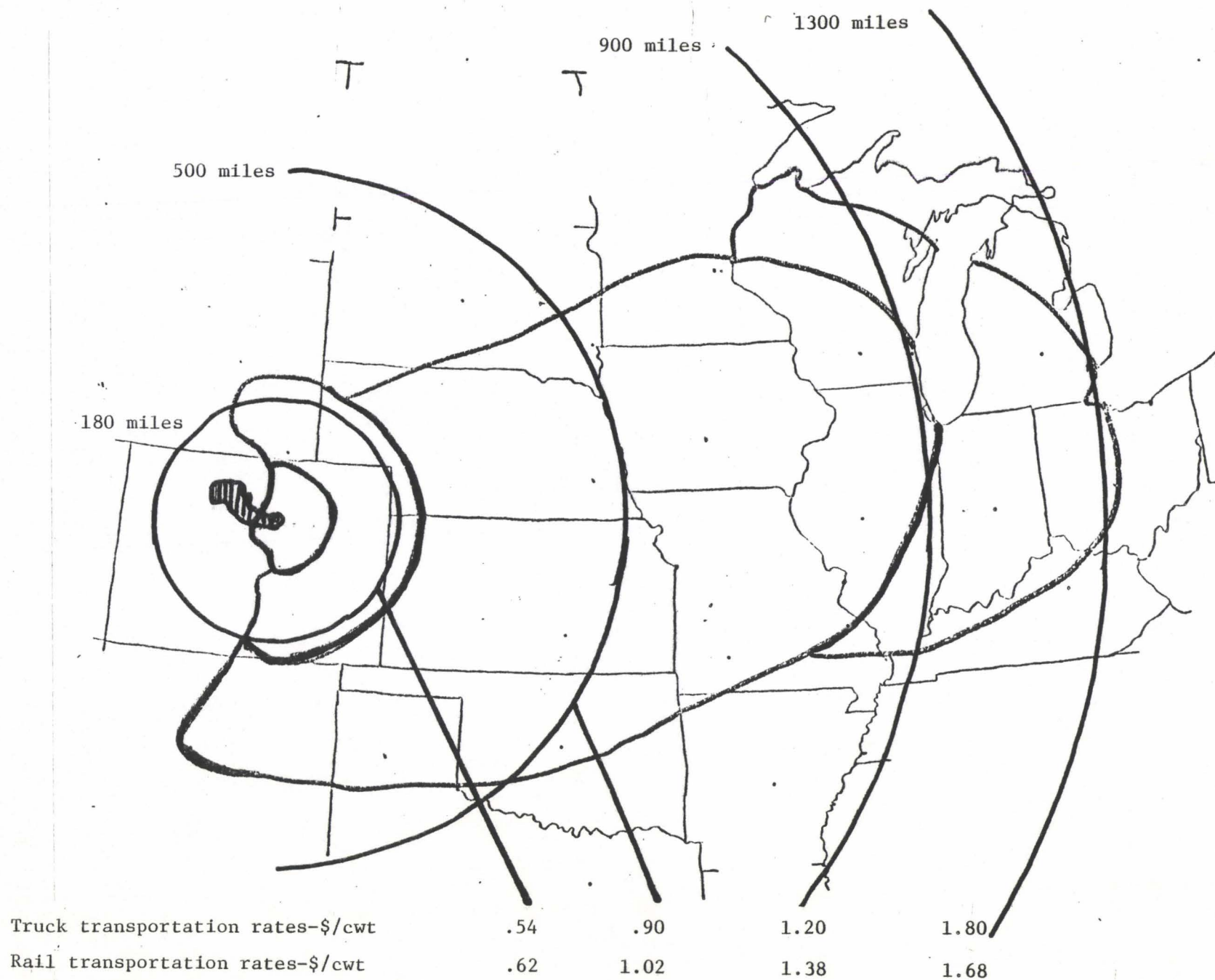


TABLE III-11 - Denver and Suburbs

Market Consumption: Resources to Products (in MCF of roundwood) - No Market Demand Restrictions

	Alt. 1	Alt. 2	Alt. 3	Alt. 4
0-5 Mile	Pallets (SFLP) 195.6	Pallets (SFLP) 195.6	Pallets (SFLP) 195.6	
	Fencing (SFLP) 58.6	Fencing (SFLP) 58.6	Fencing (SFLP) 58.6	
	Houselogs (SFLP) 334.8	Houselogs (SFLP) 334.8	Houselogs (SFLP) 334.8	Houselogs (SFLP) 20.7
	Barn Poles (PP) 12.2			
	Barn Poles (SFLP) 166.5	Barn Poles (SFLP) 178.7	Barn Poles (SFLP) 178.7	Barn Poles (SFLP) 134.5
	Corral Poles (SFLP) 9.4	Corral Poles (SFLP) 9.4	Corral Poles (SFLP) 9.4	
	Fence Posts (PP) 123.8			Fence Posts (PP) 24.0
		Fence Posts (d<5) 5.0		
		Fence Posts (SFLP) 120.7	Fence Posts (SFLP) 123.8	Fence Posts (SFLP) 68.8
	Firewood (d<5) 44.9		Firewood (d<5) 20.5	
	Firewood (d>5) 584.4	Firewood (d>5) 612.0	Firewood (d>5) 599.4	Firewood (d>5) 153.0
	Utility Poles (PP) 191.0			Utility Poles (PP) 20.6
		Utility Poles (SFLP) 191.0	Utility Poles (SFLP) 191.0	Utility Poles (d<5) 62.8
				Utility Poles (SFLP) 44.4
5-80 Mile	Beams (PP) 30.0			
	Beams (D<5) 39.7		Beams (d<5) 64.0	Beams (d<5) 21.2
	*Chips 279.1	Beams (SFLP) 78.8		
	*Sawdust 135.9	Chips 279.1	Chips 279.1	Chips 93.2
	*Shavings 113.7	Sawdust 135.9	Sawdust 135.9	Sawdust 45.5
		Shavings 113.7	Shavings 113.7	Shavings 44.9
	Boards (r.) (SFLP) 175.8	Boards (r.) (SFLP) 175.8	Boards (r.) (SFLP) 175.8	
	Timbers (PP) 97.8	Timbers (d 5) 79.5		
			Timbers (SFLP) 97.8	
	Railroad Ties (PP) 293.2	Railroad Ties (SFLP) 293.2	Railroad Ties (SFLP) 293.2	Railroad Ties (SFLP) 229.8
	Boards (p.) (SFLP) 157.4	Boards (p.) (SFLP) 157.4	Boards (p.) (SFLP) 157.4	Boards (p.) (SFLP) 23.8

* Chips, shavings and sawdust are in units of MCF of product residue, not roundwood residue.

PP = Ponderosa Pine; SFLP = Spruce-fir, Lodgepole Pine; d<5 = Ponderosa Pine dead<5 yrs.;

d>5 = Ponderosa Pine dead>5 yrs.

r. = rough

p. = planed

TABLE III-12 - Denver and Suburbs

Total Residual Return Distribution Per Market Zone and Alternative

		0-5 mile area <u>1/</u>	5-80 mile area	80-200 mile area	200-900 mile area
Alternative: #1	Total residual	\$815,474.02	\$9,141.60	\$250,215.50	\$68,547.70
	Due to live PP	304,982.00	0.00	250,215.50	0.00
	Due to dead PP	142,313.60	0.00	0.00	0.00
	Due to SFLP	326,413.90	9,141.60	0.00	68,547.70
#2	Total residual	\$816,423.53	\$9,141.60	\$255,687.70	\$68,547.70
	Due to live PP	0.00	0.00	0.00	0.00
	Due to dead PP	122,266.90	0.00	97,066.50	0.00
	Due to SFLP	692,392.10	9,141.00	158,621.20	68,547.70
#3	Total residual	\$826,732.03	\$9,141.60	\$259,208.50	\$68,547.70
	Due to live PP	0.00	0.00	0.00	0.00
	Due to dead PP	156,773.60	0.00	0.00	0.00
	Due to SFLP	628,194.50	9,141.60	259,208.50	68,547.70
#4	Total residual	\$361,296.23	\$ 0.00	\$198,125.50	\$10,364.90
	Due to live PP	45,464.00	0.00	73,803.70	0.00
	Due to dead PP	91,225.00	0.00	0.00	0.00
	Due to SFLP	210,110.00	0.00	124,321.80	10,364.90

1/ As chips, shavings and sawdust were consumed in the 0-5 mile area in each case alternative, their respective values are included in these total profit figures.

TABLE III-13 - Denver and Suburbs

Returns to Stumpage 1/

	Residual due to live PP	Residual due to dead PP	Residual due to SFLP	Residual due to residues	Total Res.
Alternative #1	\$555,197.50	\$142,313.60	\$404,103.20	\$41,764.49	\$1,143,378.79
Alternative #2	\$ 0.00	\$219,333.40	\$888,702.60	\$41,764.49	\$1,149,800.49
Alternative #3	\$ 0.00	\$156,773.60	\$965,092.30	\$41,764.49	\$1,163,630.39
Alternative #4	\$119,267.70	\$ 91,225.00	\$344,796.70	\$14,497.23	\$569,786.63

1/ Returns to stumpage is defined as the residual (R), that is, the product wholesale price less all costs including profit and risk.

TABLE III-14 - Denver and Suburbs

Mills Marginal Revenues, Marginal Costs, Profit and Risk, and Residual

MR - MC - P & R = R*

MR (Wholesale Price at Destination)

MC (Stumpage Costs and Procurement Costs and Milling Costs and
Transportation to Market Costs)

P & R (10% of MC for Profit and Risk)

R (Residual)

* (When R is less than 0 the product is considered uneconomical to
market in the marketing area)

Key

- 1) If there is no symbol in front of the product, it is currently marketed and is considered economical.
- 2) * means the product is currently marketed and is considered uneconomical based on the R value.
- 3) ** means the product is not currently marketed, but is considered economical to market based on the R value.
- 4) *** means the product is not currently marketed, and is considered uneconomical based on the R value.

- (PP) Ponderosa Pine
- (LP) Lodgepole Pine
- (SF) Spruce-fir
- (D<5yr) Ponderosa Pine that's been dead for five years or less.
- Chips (D) = chips from dead wood
- Chips (G) = Chips from green wood

TABLE III-14 - Denver and Suburbs

0-5 Mile Marketing Area

<u>Products</u>	<u>MP/(MCF)</u>	<u>MC/(MCF)</u>	<u>P & R</u>	<u>Residual/(MCF)</u>
Pallets (PP)	3,000	2,254	225	521
Pallets (LP & SF)	3,000	2,212	221	567
Pallets (D<5)	3,000	2,278	228	494
Timbers (PP)	3,240	2,793	279	168
Timbers (LP & SF)	3,240	2,751	275	214
Timbers (D<5)	3,240	2,817	282	141
Boards R (PP)	1,740	1,532	153	55
Boards R (LP & SF)	1,740	1,490	149	101
Boards R (D<5)	1,740	1,556	156	28
Boards P (PP)	3,657	2,928	293	436
Boards P (LP & SF)	3,840	2,864	286	690
Boards P (D<5)	3,474	2,964	296	214
Utility Poles (PP)	11,964	9,713	971	1,280
Utility Poles (LP & SF)	11,964	9,671	967	1,326
Utility Poles (D<5)	11,964	9,734	973	1,257
Houselogs (PP)	2,437	1,828	183	426
Houselogs (LP & SF)	2,437	1,786	179	472
Houselogs (D<5)	2,437	1,864	186	387
Barn Poles (PP)	3,564	2,758	276	530
Barn Poles (LP & SF)	3,564	2,716	272	576
Barn Poles (D<5)	3,564	2,794	279	491
Corral Poles (PP)	3,204	2,606	261	337
Corral Poles (LP & SF)	3,204	2,595	259	350
Corral Poles (D<5)	3,204	2,612	261	331
Fence Posts (PP)	4,069	2,476	248	1,345
Fence Posts (LP & SF)	4,069	2,465	246	1,358
Fence Posts (D<5)	4,069	2,482	248	1,339
Fencing (PP)	3,240	2,561	256	423
Fencing (LP & SF)	3,240	2,519	252	469
Fencing (D<5)	3,240	2,585	258	397
Firewood (D<5)	768	511	51	206
Firewood (D>5)	768	523	52	193
Railroad Ties (PP)	3,410	2,853	285	272

<u>Products</u>	<u>MP/(MCF)</u>	<u>MC/(MCF)</u>	<u>P & R</u>	<u>Residual/(MCF)</u>
Railroad Ties (LP & SF)	3,410	2,811	281	318
Railroad Ties (D<5)	3,410	2,877	288	245
Beams (PP)	4,022	3,065	306	651
Beams (LP & SF)	4,022	3,001	300	721
Beams (D<5)	4,388	3,101	310	977
Chips (G & D)	125	42	4	79
Shavings	125	42	4	79
Sawdust	125	42	4	79

5-80 Mile Marketing Area

**Pallets (PP)	3,000	2,352	235	413
**Pallets (LP & SF)	3,000	2,310	231	459
**Pallets (D<5)	3,000	2,376	238	386
Timbers (PP)	3,408	2,885	288	235
Timbers (LP & SF)	3,408	2,843	284	281
Timbers (D<5)	3,408	2,909	291	208
**Boards R (PP)	1,800	1,584	158	58
**Boards R (LP & SF)	1,800	1,542	154	104
**Boards R (D<5)	1,800	1,608	161	31
Boards P (PP)	3,657	3,007	300	350
Boards P (LP & SF)	3,840	2,943	294	603
Boards P (D<5)	3,474	3,043	304	127
Utility Poles (PP)	11,964	9,798	980	1,186
Utility Poles (LP & SF)	11,964	9,756	976	1,232
Utility Poles (D<5)	11,964	9,822	982	1,160
Houselogs (PP)	2,294	1,915	191	188
Houselogs (LP & SF)	2,294	1,873	187	234
Houselogs (D<5)	2,294	1,951	195	148
Barn Poles (PP)	3,360	2,842	284	234
Barn Poles (LP & SF)	3,360	2,800	280	280
Barn Poles (D<5)	3,360	2,878	288	194
*Corral Poles (PP)	2,880	2,691	269	-80
*Corral Poles (LP & SF)	2,880	2,680	268	-68
*Corral Poles (D<5)	2,880	2,697	270	-87

<u>Products</u>	<u>MR/(MCF)</u>	<u>MC/(MCF)</u>	<u>P & R</u>	<u>Residual/(MCF)</u>
Fence Posts (PP)	3,721	2,561	256	904
Fence Posts (LP & SF)	3,721	2,550	255	916
Fence Posts (D<5)	3,721	2,567	257	897
**Fencing (PP)	3,240	2,647	265	328
**Fencing (LP & SF)	3,240	2,605	260	375
**Fencing (D<5)	3,240	2,671	267	292
***Firewood (D<5)	588	868	87	-367
***Firewood (D>5)	588	880	88	-380
Railroad Ties (PP)	3,410	2,946	295	169
Railroad Ties (LP & SF)	3,410	2,904	290	216
Railroad Ties (D<5)	3,410	2,970	297	143
Beams (PP)	4,022	3,144	314	564
Beams (LP & SF)	4,022	3,080	308	634
Beams (D<5)	4,388	3,180	318	890
Chips (G & D)	187	152	15	20
Shavings	187	152	15	20
Sawdust	187	152	15	20

80-200 Mile Marketing Area

**Pallets (PP)	3,000	2,537	254	209
**Pallets (LP & SF)	3,000	2,495	249	256
**Pallets (D<5)	3,000	2,561	256	183
Timbers (PP)	5,388	3,070	307	2,011
Timbers (LP & SF)	5,388	3,028	303	2,057
Timbers (D<5)	5,388	3,094	309	1,985
Boards P (PP)	3,474	3,093	309	72
Boards P (LP & SF)	3,657	3,029	303	325
***Boards P (D<5)	3,382	3,129	313	-59
Utility Poles (PP)	11,964	10,005	1,000	959
Utility Poles (LP & SF)	11,964	9,963	996	1,005
Utility Poles (D<5)	11,964	10,029	1,003	932
Houselogs (PP)	2,437	2,105	210	122
Houselogs (LP & SF)	2,437	2,063	206	168
Houselogs (D<5)	2,437	2,141	214	82
Barn Poles (PP)	3,408	3,046	305	57
Barn Poles (LP & SF)	3,408	3,004	300	104

<u>Products</u>	<u>MP/(MCF)</u>	<u>MC/(MCF)</u>	<u>P & R</u>	<u>Residual/(MCF)</u>
Barn Poles (D<5)	3,408	3,082	308	18
Fence Posts (PP)	4,069	2,768	277	1,024
Fence Posts (LP & SF)	4,069	2,757	276	1,036
Fence Posts (D<5)	4,069	2,774	277	1,018
**Fencing (PP)	3,240	2,862	286	92
**Fencing (LP & SF)	3,240	2,820	282	138
**Fencing (D<5)	3,240	2,886	289	65
Railroad Ties (PP)	4,488	3,138	314	1,036
Railroad Ties (LP & SF)	4,488	3,096	310	1,082
Railroad Ties (D<5)	4,488	3,162	316	1,010
Beams (PP)	3,657	3,230	323	104
Beams (LP & SF)	3,657	3,166	317	174
Beams (D<5)	4,022	3,266	327	429
*Corral P (All)	—	—	—	-164
***Boards R (All)	—	—	—	-(very high)
***Firewood (All)	—	—	—	-(very high)
***Chips (All)	—	—	—	-(very high)
***Shavings (All)	—	—	—	-(very high)
***Sawdust (All)	—	—	—	-(very high)

200-900 Mile Marketing Area

Timbers (PP)	6,192	3,920	392	1,880
Timbers (LP & SF)	6,192	3,878	388	1,926
Timbers (D<5)	6,192	3,944	394	1,804
**Boards P (PP)	3,657	3,261	326	70
**Boards P (LP & SF)	4,388	3,197	320	871
***Boards P (D<5)	3,474	3,297	330	-153
Utility Poles (PP)	11,964	10,839	1,084	41
Utility Poles (LP & SF)	11,964	10,797	1,080	87
Utility Poles (D<5)	11,964	10,863	1,086	15
Houselogs (PP)	2,867	2,425	242	200
Houselogs (LP & SF)	2,867	2,383	238	246
Houselogs (D<5)	2,867	2,461	246	160
Fence Posts (PP)	4,069	3,602	360	107
Fence Posts (LP & SF)	4,069	3,591	359	119

<u>Products</u>	<u>MR/(MCF)</u>	<u>MC/(MCF)</u>	<u>P & R</u>	<u>Residual/(MCF)</u>
Fence Posts (D<5)	4,069	3,608	361	100
Railroad Ties (PP)	5,268	3,980	398	890
Railroad Ties (LP & SF)	5,268	3,938	394	936
Railroad Ties (D<5)	5,268	4,004	400	864
**Beams (PP)	4,022	3,398	340	284
**Beams (LP & SF)	4,022	3,334	333	355
**Beams (D<5)	4,388	3,434	343	611
***Other Products	-	-	-	-(very high)

900-1300 Mile Marketing Area

***Boards P (PP)	3,657	3,473	347	-163
**Boards P (LP & SF)	4,388	3,409	341	638
***Boards P (D<5)	3,474	3,509	351	-386
**Beams (PP)	4,022	3,610	361	51
**Beams (LP & SF)	4,022	3,546	355	121
**Beams (D<5)	4,388	3,646	365	377
**Chips (G & D)	244	212	21	11
***Timbers (All)	-	-	-	-582
***Railroad Ties (All)	-	-	-	-82
***Other Products	-	-	-	-(very high)

TABLE III-15 - Cost Breakdown Sheet for Denver and Suburbs Processing Area

	Stumpage 1/		Procurement		Milling		P&R	Transp.	Transp.	Transp.	Transp.	Transp.	Product V	Product V	Product V	Product V	Product V	
Products	MBF	MCF	MBF	MCF	MBF	MCF	%	(0-5)	(5-80)	(80-200)	(200-900)	(900-1300)	(0-5)	(5-80)	(80-200)	(200-900)	(900-1300)	
	MBF	MCF	MBF	MCF	MBF	MCF		MCF	MCF	MCF	MCF	MCF	MBF	MCF	MBF	MCF	MBF	MCF
Pallets (PP)	3.00	36.00	64.51	774	49.99	1440	.10	4.00	102.45	286.88	—	—	250	3000	250	3000	250	3000
Pallets (LP)	4.00	48.00	60.01	720	"	"	"	"	"	"	—	—	"	"	"	"	—	—
Pallets (SF)	"	"	"	"	"	"	"	"	"	"	—	—	"	"	"	"	—	—
Pallets (D<5)	.50	6.00	69.01	828	"	"	"	"	"	"	—	—	"	"	"	"	—	—
Timbers (PP)	3.00	36.00	64.51	774	165	1980	.10	3.20	95.20	279.61	1,130	2,085	270	3240	284	3408	449	5388
Timbers (LP)	4.00	48.00	60.01	720	"	"	"	"	"	"	"	"	"	"	"	"	516	6192
Timbers (SF)	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
Timbers (D<5)	.50	6.00	69.01	828	"	"	"	"	"	"	"	"	"	"	"	"	"	"
Boards R (PP)	3.00	36.00	64.51	774	59.99	720	.10	1.80	54.00	—	—	—	145	1740	150	1800	—	—
Boards R (LP)	4.00	48.00	60.01	720	"	"	"	"	"	—	—	—	"	"	"	"	—	—
Boards R (SF)	"	"	"	"	"	"	"	"	"	—	—	—	"	"	"	"	—	—
Boards R (D<5)	.50	6.00	69.01	828	"	"	"	"	"	—	—	—	"	"	"	"	—	—
Boards P (PP)	3.00	54.85	64.51	1179	92.49	1691	.10	2.74	82.28	167.85	336	548	200	3657	200	3657	190	3474
Boards P (LP)	4.00	73.14	60.01	1097	"	"	"	"	"	"	"	"	210	3840	210	3840	200	3657
Boards P (SF)	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	240	4388
Boards P (D<5)	.50	9.14	69.01	1261	"	"	"	"	"	"	"	"	190	3474	190	3474	185	3382
Utility Poles (PP)	3.00	36.00	64.51	774	742	8900	.10	3.22	88.06	295.14	1,129	2,085	997	11964	997	11964	997	11964
Utility Poles (LP)	4.00	48.00	60.01	720	"	"	"	"	"	"	"	"	"	"	"	"	"	"
Utility Poles (SF)	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
Utility Poles (D<5)	.50	6.00	69.01	828	"	"	"	"	"	"	"	"	"	"	"	"	"	"
Houselogs P (PP)	2.00	24.00	64.51	774	85.58	1027	.10	3.20	90.38	279.63	600	—	203	2437	191	2294	203	2437
Houselogs P (LP)	3.00	36.00	60.01	720	"	"	"	"	"	"	"	—	"	"	"	"	238	2867
Houselogs P (SF)	"	"	"	"	"	"	"	"	"	"	"	—	"	"	"	"	"	"
Houselogs P (D<5)	.50	6.00	69.01	828	"	"	"	"	"	"	"	—	"	"	"	"	"	"
Barn Poles (PP)	2.00	24.00	64.51	774	163.09	1957	.10	3.18	86.95	291.39	—	—	297	3564	280	3360	284	3408
Barn Poles (LP)	3.00	36.00	60.01	720	"	"	"	"	"	"	—	—	"	"	"	"	—	—
Barn Poles (SF)	"	"	"	"	"	"	"	"	"	"	—	—	"	"	"	"	—	—
Barn Poles (D<5)	.50	6.00	69.01	828	"	"	"	"	"	"	—	—	"	"	"	"	—	—
Corral Poles (PP)	2.00	24.00	41.37	496	173.60	2083	.10	3.22	88.06	295.14	—	—	267	3204	240	2880	251	3012
Corral Poles (LP)	3.00	36.00	39.40	473	"	"	"	"	"	"	—	—	"	"	"	"	—	—
Corral Poles (SF)	"	"	"	"	"	"	"	"	"	"	—	—	"	"	"	"	—	—
Corral Poles (D<5)	.50	6.00	43.34	520	"	"	"	"	"	"	—	—	"	"	"	"	—	—

TABLE III-15 (Cont.)

	Stumpage		Procurement		Milling		P&R	Transp. (0-5)	Transp. (5-80)	Transp. (80-200)	Transp. (200-900)	Transp. (900-1300)	Product V (0-5) 2/		Product V (5-80)		Product V (80-200)		Product V (200-900)		Product V (900-1300)	
Products	MBF	MCF	MBF	MCF	MBF	MCF		MCF	MCF	MCF	MCF	MCF	MBF	MCF	MBF	MCF	MBF	MCF	MBF	MCF	MBF	MCF
Fence Posts (PP)	2.00	24.00	41.37	496	162.73	1953	.10	3.22	88.06	295.14	1,129	—	339	4069	310	3721	339	4069	339	4069	—	—
Fence Posts (LP)	3.00	36.00	39.40	473	"	"	"	"	"	"	"	—	"	"	"	"	"	"	"	"	—	—
Fence Posts (SF)	"	"	"	"	"	"	"	"	"	"	"	—	"	"	"	"	"	"	"	"	—	—
Fence Posts (D<5)	.50	6.00	43.34	520	"	"	"	"	"	"	"	—	"	"	"	"	"	"	"	"	—	—
Fencing (PP)	3.00	36.00	64.51	774	145.69	1748	.10	3.25	89.28	303.97	—	—	270	3240	270	3240	270	3240	—	—	—	—
Fencing (LP)	4.00	48.00	60.01	720	"	"	"	"	"	"	—	—	"	"	"	"	"	"	—	—	—	—
Fencing (SF)	"	"	"	"	"	"	"	"	"	"	—	—	"	"	"	"	"	"	—	—	—	—
Fencing (D<5)	.50	6.00	69.01	828	"	"	"	"	"	"	—	—	"	"	"	"	"	"	—	—	—	—
Firewood (D<5)	.50	6.00	40.58	487	0	0	.10	17.60	374.95	—	—	—	64	768	49	588	—	—	—	—	—	—
Firewood (D>5)	"	"	41.58	499	"	"	"	"	"	—	—	—	"	"	"	"	—	—	—	—	—	—
R.R. Ties (PP)	3.00	36.00	64.51	774	170	2040	.10	3.20	96.15	288.50	1,130	2,085	284	3410	284	3410	374	4488	439	5268	400	4800
R.R. Ties (LP)	4.00	48.00	60.01	720	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
R.R. Ties (SF)	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
R.R. Ties (D<5)	.50	6.00	69.01	828	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
Beams (PP)	3.00	54.85	64.51	1179	100.0	1828	.10	2.74	82.28	167.85	336	548	220	4022	220	4022	200	3657	220	4022	220	4022
Beams (LP)	4.00	73.14	60.01	1097	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
Beams (SF)	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
Beams (D<5)	.50	9.14	69.01	1261	"	"	"	"	"	"	"	"	240	4388	240	4388	220	4022	240	4388	240	4388
Chips (D)	—	—	—	—	3.00	36.00	.10	5.81	116.27	349.00	—	176.31	—	125	—	187	—	—	—	—	—	244
Chips (G)	—	—	—	—	"	"	"	"	"	"	—	"	—	11	—	11	—	—	—	—	—	11
Shavings	—	—	—	—	3.00	36.00	.10	5.81	116.27	349.00	—	—	—	125	—	187	—	—	—	—	—	—
Sawdust	—	—	—	—	3.00	36.00	.10	5.81	116.27	349.00	—	—	—	125	—	187	—	—	—	—	—	—

1/ All figures represent \$/MBF or \$/MCF as indicated.

2/ PROD V - (product value) refers to the marginal revenue from each product in a given market zone.

Case Study III - Denver and Suburbs Tributary Area

Summary AnalysisRaw Material Supply Versus Amount Consumed

As in the two previous cases, Fort Collins-Loveland and Boulder-Longmont, each alternative yields, or makes available, a raw material supply in excess of the total consumed.

SUPPLY-CONSUMPTION DIFFERENTIAL			
Alternative 1	2	3	4
3986.5 MCF	3794.0 MCF	3784.5 MCF	459.0 MCF

If supply were actually to each this level, a residual of raw material would exist because of limited production capacity for the processing area. An examination of TABLE III-10 reveals that alternatives 1, 2, and 3 have approximately the same supply in total with some variation in ponderosa pine quantity. For each alternative, including #4, all ponderosa pine dead <5 years was consumed and in each case except #4 nearly all dead >5 years was consumed regardless of the goals. The utilization of dead <5 years was due primarily to its use for beams, for which dead <5 years returns the highest economic residual. In the case of the second alternative, the dead <5 years was utilized as timbers, again returning the highest economic residual for timbers. (Sec. III-14).

UTILIZATION OF PONDEROSA PINE TYPES

A high percentage of ponderosa pine is used in Alternative 1 due to the priority goal of using ponderosa sawtimber and poletimber. The recommended cut on these types results in more sawtimber and less poletimber supply available in Alternative 1 than provided by the allowable cut. (See Table III-2).

Alternative	1	2	3	4	
Ponderosa Pine Supply	1440.0	1227.0	1227.0	814.0	MCF
Ponderosa Pine Used	1416.4	696.0	683.4	355.0	MCF

In each of alternatives 1, 2, and 3, a large part of the wood used is due to dead >5 years pine utilized as firewood.

UTILIZATION OF BEETLE-KILLED PONDEROSA PINE

The table below summarizes, in total, the beetle-killed pine used in the Denver and Suburbs case study.

<u>Alternative</u>	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	
Supply	696.0	696.0	696.0	696.0	MCF
Consumed	668.4	696.0	683.4	237.0	MCF

In alternatives 1, 2, and 3, the supply of beetle-killed wood is nearly all consumed, in each case as firewood. Beetle-killed wood dead <5 years was consumed as higher value products in almost all cases. This utilization was in the form of beams and fence posts.

Alternative 4, having the same supply of beetle-killed wood as the others, used a lesser amount due to its restricted capacity.

Alternative 2 showed the highest utilization rate since the priority goal promotes use of beetle-killed wood. This alternative also returned the highest profit due strictly to dead ponderosa pine because of its use for timbers in the 80-200 mile marketing zone. (See Table III-11). Dead ponderosa pine was used here even though it gave less of a return, compared to spruce-fir and ponderosa pine due to the priority goal of removal of the previous year mortality. (See Table III-14).

OVERALL RETURNS TO STUMPAGE

	Alt. + 1	2	3	4
Ponderosa pine as % of total supply	22.2	19.5	19.5	60.9
" " used	56.3	28.0	27.3	40.5
Residual as a % of Total residual	61.0	19.1	13.5	36.9
Spruce-fir/Lodgepole pine as % of				
" " total supply	77.8	80.5	80.5	39.1
" " used	43.7	72.0	72.7	59.5
Residual as a % of Total residual	35.3	77.3	82.9	60.5
Total residual revenue*	\$1,143,378	1,149,800	1,163,630	569,789

*Revenue figures include revenue due to mill residue.

The table above presents comparisons of raw material used and the amount of total revenue which it produces. Due to the priority's goal of using

ponderosa pine in alternative 1, ponderosa pine represented a greater proportion of the total consumed than in any other alternative. In this alternative, as ponderosa pine supplies were exhausted, spruce-fir and lodgepole pine were used in the formation of products with the highest return, supporting the second goal of maximization of returns to stumpage.

Alternative 3, with a goal of revenue maximization, used the highest proportion of total supply, 72.7%, in the form of spruce-fir, lodgepole pine products. As spruce-fir, lodgepole pine products yield the highest return, the revenue share due it, 82.9%, supports its use.

Alternative 4 reflects a low current supply of spruce-fir and lodgepole pine. The single goal here is to maximize returns. As has been established, the use of spruce-fir, lodgepole produces this result. However, only 39% of the supply is of this type, therefore, ponderosa pine will be used, at a less return rate, when spruce-fir, lodgepole is exhausted.

In alternative 4, the raw material supply is sufficiently low as to leave some product lines completely vacant. Since the total raw material supply is limited, many products such as pallets, fencing, and rough boards were not produced at all. (See Table III-2).

MARKET CONSUMPTION OF PRODUCTS

Since profit maximization is a goal in each alternative, the goal program will attempt to allocate all raw materials to those products in market zones which will yield the greatest return. Table III-11 shows this consumption by marketing zone, and lists the actual amount consumed in MCF. In the Denver study, most of the consumption of products is within the 0-5 mile marketing area, or the local area, with a few products marketed at greater distances. This is due to a higher return possible in the immediate area resulting from higher values per MCF of product and lesser transportation costs. (See Table III-14). Those products marketed in the 80-200 mile and 200-900 mile

area had greater value in these market zones and provided greater residual regardless of transportation costs. For example,

<u>Timbers - Market Value</u>					
	0-5	5-80	80-200	200-900	Mile zone
Market Value	\$3240	3408	5388	6192	
\$/MCF					

GENERAL CONSUMPTION BREAKDOWN

The general consumption breakdown of products by market zones appears to follow the general trend below: (when given no demand constraints)

0-5 mile	pallets	5-80 mile	boards - rough
	fencing		
	housetlogs	80-200 mile	timber
	barn poles		railroad ties
	corral poles		
	fence posts	200-900 mile	boards - planed
	firewood		
	utility poles		
	beams		

OPTIMUM PONDEROSA PINE UTILIZATION

Overall, the greatest potential for utilization of ponderosa pine lies with alternative 1, which yields the highest return to live ponderosa pine. Alternative 2 yields the highest return due strictly to beetle-killed dead pine. Thus, for the purpose of maximizing ponderosa pine utilization, a combination of alternatives 1 and 2 would yield would include those products from ponderosa pine alternative 1 which maximizes returns and products from beetle-killed pine in alternative 2 which maximizes returns.

Ponderosa Pine Products

barn poles
fence posts
utility poles
beams
railroad ties
timbers

Beetle-killed Pine Products

firewood
beams
timbers

PRODUCT PROFIT POTENTIALS

The study of revenue and cost figures in Table III-15 has shown, in many cases, market potential for products in market zones not currently reached. These products are summarized by marketing zones below. While some of these products may be marketed in other zones at a greater residual return, significant returns nevertheless are possible even with the addition of transportation costs.

5-80 mile zone: $\frac{1}{-}$

<u>Products</u>	<u>Residual (\$/MCF of roundwood)</u>
pallets - PP	206.50
pallets - SFLP	230.00
pallets - D<5	193.00
boards r. - PP	29.00
boards r. - SFLP	52.00
boards r. - D<5	15.50
fencing - PP	164.00
fencing - SFLP	187.50
fencing - D<5	146.00

80-200 mile zone:

<u>Products</u>	<u>Residual (\$/MCF of roundwood)</u>
pallets - PP	104.50
pallets - SFLP	148.00
pallets - D<5	91.50
fencing - PP	46.00
fencing - SFLP	69.00
fencing - D<5	32.50

200-900 mile zone:

<u>Products</u>	<u>Residual (\$/MCF of roundwood)</u>
boards, planed - PP	35.00
boards, planed - SFLP	435.50
beams - PP	142.00
beams - SFLP	177.50
beams - D<5	305.50

900-1300 mile zone:

<u>Products</u>	<u>Residual (\$/MCF of roundwood)</u>
boards, planed - SFLP	419.00
beams - PP	25.50
beams - SFLP	60.50
beams - D<5	188.50

1 SFLP = Spruce-fir, Lodgepole pine; PP = Ponderosa pine; D<5 = dead less than 5 yrs.

The program as presently written reflects these products and they form part of the consumption and profit figures in the marketing zones in which they are listed.

There exists one product which, according to this study, is found to be presently marketed at a loss per MCF. Corral poles are presently marketed to the 5-80 mile zone yielding a net residual of - \$68.00 to - \$87.00 depending on the material from which it is made. (See Table III-14).

Denver and Suburbs Tributary Area

Sensitivity Analysis

As in the original goal program run, the supply of raw material available in each alternative exceeded the amount actually consumed. In this, sensitivity analysis, the amount of material consumed was less than that level consumed in the original analysis. (See Table III-16).

Resources Used (MCF of roundwood)

<u>Alternative</u>	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	
Original Analysis	2514	2490	2500	877	MCF
Sensitivity Analysis	1955	1930	1904	739	MCF

This drop in the level of raw material used, or consumed, is due in part to the marginal analysis of products. As a result of this analysis, some products were found to be uneconomical to market in certain zones due to a negative residual. If this result was the case, the product, within the goal program, was not made available for marketing, or consumption, in the uneconomical zone. In the Denver and Suburbs case study, this outcome resulted in some products being restricted to sales only in the 0-5 mile marketing area. The sensitivity analysis imposed a constrained consumption level in the 0-5 mile market zone. Thus, many products were simply produced up to that specified level and further production terminated. The end result was a lower level of consumption of a given product and, thus, a lesser amount of raw material used. In this case study, the products most affected by the consumption restriction combined with further restriction of uneconomical residuals in more distant market zones were firewood and corral poles. (See Table III-11 and Table III-20).

TABLE III-16 - Denver and Suburbs: SENSITIVITY ANALYSIS

Raw Material Supplies Versus Raw Material UsedAlternative 1

<u>Supply (MCF of roundwood):</u>			<u>Resources Used (MCF of roundwood):</u>		
SFLP	sawtimber	3226.0		587.4	
SFLP	poletimber	1831.0		502.2	
PP	sawtimber	612.0		612.0	
PP	poletimber	136.0		136.0	
PP	dead < 5 yrs.	84.0		84.0	
PP	dead > 5 yrs.	612.0		33.6	
TOTAL:		6501.0	MCF	1955.2	MCF

Alternative 2

<u>Supply (MCF of roundwood):</u>			<u>Resources Used (MCF of roundwood):</u>		
SFLP	sawtimber	3226.0		1150.4	
SFLP	poletimber	1831.0		635.1	
PP	sawtimber	338.0		0.0	
PP	poletimber	193.0		0.0	
PP	dead < 5 yrs.	84.0		84.0	
PP	dead > 5 yrs.	612.0		61.2	
TOTAL:		6284.0	MCF	1930.7	MCF

Alternative 3

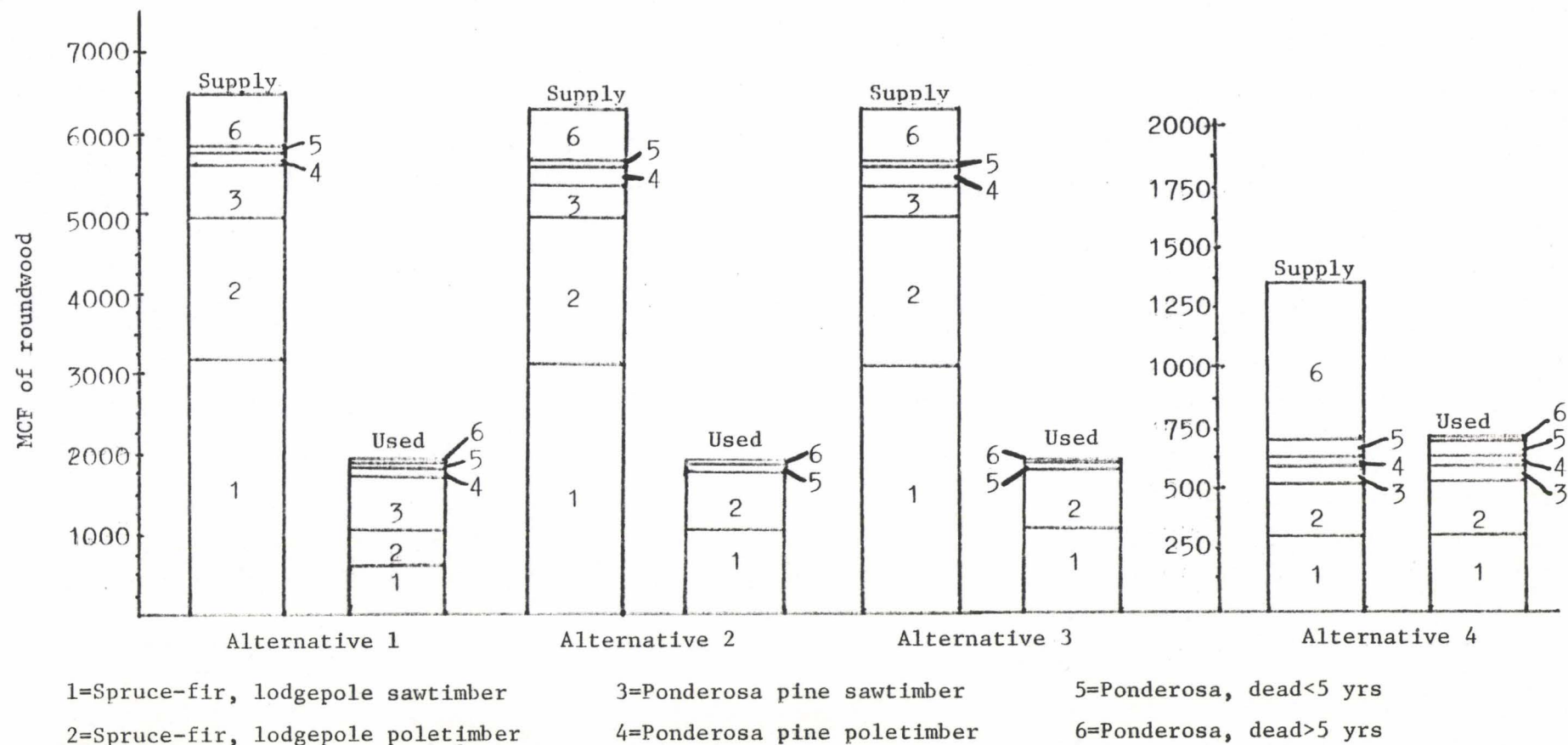
<u>Supply (MCF of roundwood):</u>			<u>Resources Used (MCF of roundwood):</u>		
SFLP	sawtimber	3226.0		1169.4	
SFLP	poletimber	1831.0		638.2	
PP	sawtimber	338.0		0.0	
PP	poletimber	193.0		0.0	
PP	dead < 5 yrs.	84.0		84.0	
PP	dead > 5 yrs.	612.0		48.6	
TOTAL:		6284.0	MCF	1904.2	MCF

Alternative 4

<u>Supply (MCF of roundwood):</u>			<u>Resources Used (MCF of roundwood):</u>		
SFLP	sawtimber	298.0		298.0	
SFLP	poletimber	224.0		224.0	
PP	sawtimber	94.0		94.0	
PP	poletimber	24.0		24.0	
PP	dead < 5 yrs.	84.0		84.0	
PP	dead > 5 yrs.	612.0		15.3	
TOTAL:		1336.0	MCF	739.3	MCF

TABLE III-17 - Denver and Suburbs: SENSITIVITY STUDY

Raw Material Supply versus Raw Material Consumed



The table below shows the difference in raw material used between the original alternative and the sensitivity analysis.

Raw Material Used -- Original Alternative vs Sensitivity Analysis
(MCF of roundwood)

		Alt 1-Alt 1-s*	Alt 2-Alt 2-s	Alt 3-Alt 3-s	Alt 4-Alt 4-s
SFLP	sawtimber	0.0	0.0	0.0	0.0
SFLP	poletimber	8.5	8.5	8.5	0.0
PP	sawtimber	0.0	0.0	0.0	0.0
PP	poletimber	0.0	0.0	0.0	0.0
PP	dead <5 yrs.	0.0	0.0	0.0	0.0
PP	dead >5 yrs.	550.8	550.8	550.8	137.7

*Alt. 1-s refers to the sensitivity analysis program run using alternative 1 constraints and goals outlined in Tables III-6, 7, 8, and 9.

Based on the lower consumption and use of products and raw material, the returns to stumpage for each alternative are less in the sensitivity analysis as compared to the original alternative. This is due to two reasons. First, some products will maximize residual return if marketed in the first market zone. The market zone consumption for that product is limited and the remaining production capacity of that product is consumed in more distant markets at a lower rate of return.

Secondly, in reference to material discussed earlier, when market consumption was severely restricted due to the combination of consumption limitation and uneconomical residuals in zones beyond the 0-5 mile marketing zone, total product consumption and resource use was curtailed, eliminating a residual return associated with it. Tables III-18 and 19 reveal this loss. The table below illustrates the differences in total returns by zones between the original alternatives and the sensitivity analysis alternatives.

Difference in Returns to Stumpage--Original Alternatives - Sensitivity Alternative

	0-5 mile	5-80 mile	80-200 mile	200-900 mile	Total Difference
Alt 1-Alt 1-s	-\$696,133	-223,898	-114,073	-74,119	284,041
Alt 2-Alt 2-s	-\$697,319	-223,651	-115,410	-74,119	284,137
Alt 3-Alt 3-s	-\$706,407	-232,739	-115,410	-74,119	284,137
Alt 4-Alt 4-s	-\$300,516	-121,613	-83,000	0.0	95,485

Due to the demand limitation, the consumption pattern was also changed. The table below lists the sensitivity analysis' general consumption pattern of products as compared to the general consumption in the original alternatives. As is expected, the consumption pattern is now drawn out to further distant markets to utilize the supply. Commonly, in this case, less revenue is received per MCF of a given product.

General Product Consumption Breakdown

<u>Original Alternatives/Sensitivity</u>		
0-5 mile zone	pallets	pallets
	fencing	fencing
	houselogs	houselogs
	barn poles	barn poles
	corral poles	corral poles
	fence posts	fence posts
	firewood	firewood
	utility poles	utility poles
	beams	beams
	chips	chips
	shavings	shavings
	sawdust	sawdust
5-80 mile zone	boards, rough	boards, rough
		pallets
		fencing
		barn poles
		utility poles
80-200 mile zone		beams
	timbers	timbers
	railroad ties	railroad ties
200-900 mile zone		fence posts
	boards, planed	boards, planed houselogs

Exact amounts of these products consumed are listed in Tables III-11 and 20.

TABLE III-18 - Denver and Suburbs: Sensitivity Study

Total Return Distribution Per Market Zone and Alternative

		0-5 mile zone	5-80 mile zone	80-200 mile zone	200-900 mile zone
Alt. 1	total returns	\$119,341.00*	\$233,040.00	\$364,289.10	\$142,667.50
	due to PP live	35,432.00	110,337.40	364,289.10	0.00
	due to PP dead	15,980.70	18,245.00	0.00	0.00
	due to SFLP	26,326.90	104,457.60	0.00	142,667.50
Alt. 2	total returns	\$119,103.90*	\$232,793.40	\$371,098.10	\$142,667.50
	due to PP live	0.00	0.00	0.00	0.00
	due to PP dead	15,962.50	0.00	97,066.50	0.00
	due to SFLP	61,525.00	232,793.40	274,031.60	142,667.50
Alt. 3	total returns	\$120,325.00*	\$241,881.40	\$374,618.90	\$142,667.50
	due to PP live	0.00	0.00	0.00	0.00
	due to PP dead	15,785.70	31,595.00	0.00	0.00
	due to SFLP	62,922.90	210,286.40	374,618.90	142,667.50
Alt. 4	total returns	\$ 60,780.17*	\$121,613.80	\$281,542.70	\$ 10,364.90
	due to PP live	0.00	12,215.80	98,379.70	0.00
	due to PP dead	4,223.00	10,502.00	39,289.00	0.00
	due to SFLP	42,053.80	98,896.00	143,874.00	10,364.90

*Chips, sawdust, and shavings included in this figure.

TABLE III-19 - Denver and Suburbs: Sensitivity Study

Returns to Stumpage

	revenues due to Ponderosa Pine	revenues due to dead Ponderosa Pine	revenues due to Spruce-fir-Lodgepole	revenues due to mill residues	residual total
Alt. 1	\$510,058.50	34,225.70	273,452.00	41,601.40	\$859,337.60
Alt. 2	\$ 0.00	113,029.00	711,017.50	41,616.40	\$865,662.90
Alt. 3	\$ 0.00	47,380.40	790,495.70	41,616.40	\$879,492.50
Alt. 4	\$110,595.50	54,014.00	295,188.70	14,503.37	\$474,301.57

TABLE III-20 - Denver and Suburbs: Sensitivity Study

Market Consumption: Resources to Product (MCF of roundwood)

	<u>Alternative 1</u>		<u>Alternative 2</u>		<u>Alternative 3</u>		<u>Alternative 4</u>	
0-5 Mile Zone	Pallets (SFLP)	19.6	Pallets (SFLP)	19.6	Pallets (SFLP)	19.6		
	Fencing (SFLP)	5.8	Fencing (SFLP)	5.8	Fencing (SFLP)	5.8		
	Houselogs (SFLP)	33.5	Houselogs (SFLP)	33.5	Houselogs (SFLP)	33.5	Houselogs (SFLP)	25.4
	Barn p. (PP)	12.2						
	Barn p. (SFLP)	5.7	Barn p. (SFLP)	17.9	Barn p. (SFLP)	17.9	Barn p. (SFLP)	13.5
	Corral p. (SFLP)	0.9	Corral p. (SFLP)	0.9	Corral p. (SFLP)	0.9	Corral p. (SFLP)	0.7
	Fence p. (PP)	12.4						
			Fence p. (d<5)	3.1				
			Fence p. (SFLP)	9.3	Fence p. (SFLP)	12.4	Fence p. (SFLP)	9.3
	Firewood (d<5)	44.6			Firewood (d<5)			
	Firewood (d>5)	33.6	Firewood (d>5)	61.2	Firewood (d>5)	48.6	Firewood (d>5)	15.3
	Utility p. (PP)	19.2						
			Utility p. (SFLP)	19.2	Utility p. (SFLP)	19.2	Utility p. (SFLP)	14.2
	Beams (d<5)	6.3			Beams (d<5)	6.3	Beams (d<5)	2.1
			Beams (SFLP)	7.8				
5-80 Mile Zone	Chips*	279.1	Chips*	279.1	Chips*	279.1	Chips*	93.24
	Sawdust	135.85	Sawdust	135.85	Sawdust	135.85	Sawdust	45.39
	Shavings	111.65	Shavings	111.84	Shavings	111.84	Shavings	44.96
	Pallets (SFLP)	176.0	Pallets (SFLP)	176.0	Pallets (SFLP)	176.0		
	Fencing (SFLP)	52.8	Fencing (SFLP)	52.8	Fencing (SFLP)	52.8		
	Boards R. (SFLP)	175.8	Boards R. (SFLP)	175.8	Boards R. (SFLP)	175.8		
	Barn p. (SFLP)	160.8	Barn p. (SFLP)	160.8	Barn p. (SFLP)	160.8	Barn p. (SFLP)	115.6
	Utility p. (PP)	171.8						
			Utility p. (SFLP)	171.8	Utility p. (SFLP)	171.8	Utility p. (SFLP)	108.0
	Beams (PP)	30.0						
	Beams (d<5)	33.1			Beams (d<5)	57.3	Beams (d<5)	19.1
			Beams (SFLP)	71.0				
80-200 Mile Zone	Timbers (PP)	97.8					Timbers (PP)	73.4
			Timbers (d<5)	79.0				
					Timbers (SFLP)	97.8		
	Fence p. (PP)	111.4					Fence p. (PP)	24.0
			Fence p. (SFLP)	111.4	Fence p. (SFLP)	111.4	Fence p. (SFLP)	59.5
200-900 Mile Zone	R.R. Ties (PP)	293.2						
			R.R. Ties (SFLP)	293.2	R.R. Ties (SFLP)	293.2	R.R. Ties (d<5)	62.8
							R.R. Ties (SFLP)	152.0
200-900 Mile Zone	Boards P. (SFLP)	157.4	Boards P. (SFLP)	157.4	Boards P. (SFLP)	157.4	Boards P. (SFLP)	23.8
	Houselogs (SFLP)	301.3	Houselogs (SFLP)	301.3	Houselogs (SFLP)	301.3		

*Chips, shavings, and sawdust are in terms of product, not roundwood.

CASE STUDY IV: PINE-BAILEY CASE STUDY

The Pine-Bailey Case Study has a timber procurement base of over 380,000 acres. This procurement acreage was developed in CSU Report #2192. As detailed earlier in this report, the procurement zone encompasses acres of present or potential supply for area mills. To avoid the complexity of overlapping procurement areas between processing centers, the centers holding a competitive advantage was considered to be the sole timber buying center. The Pine-Bailey procurement area encompasses private and state land in portions of Park and Jefferson Counties as well as parts of the Arapahoe and Pike National Forests. Figure IV-1 illustrates as a percentage, the ownership portions encompassing the procurement area as well as accessible acreage within these areas. Table IV-1 lists acreage totals for each ownership.

The timber supply in terms of allowable cut, current cut and recommended annual cut were obtained from CSU Project #2192. The raw material supply, as displayed in Table IV-2 illustrates the cut determinations.

The four alternatives for this case study will display the individual input values to represent the four sets of overriding goals. The constraints would represent types and levels of timber cut per species and mill capacities for various products with a standard return per product for all subsequent alternatives, designed in such a way as to implement the goals.

Production capability is shown in Table IV-3 with Table IV-4 displaying current annual production for area mills. A definition of the products produced in the Pine-Bailey center and their respective conversion factors is

shown in Table IV-5. This table displays the products standard finished size, the amount of wood per product and in appropriate cases a conversion from cubic feet of products to board feet.

The results of implementing each alternative are individually briefed in Tables IV-6 through IV-9. The tables show the constraints and goals for each goal program run. Raw material supply as well as product capacity, reflective of the above constraints, are also shown.

Resources used for different material classes are also displayed adjacent to raw material available, in the form of percentages, in Table IV-10. Thus, examining our output strictly in terms of supply the observer may determine the impact of a certain alternative strategy on the consumption of a certain size and species class of timber relative to the others.

The total amount of each material class is broken down into the ultimate products in Table IV-11. The total residual due to the allocation of raw materials to given products is illustrated in Table IV-12. The table sums values for given numbers of products sold in a market area by raw material class. The material classes here are grouped into ponderosa pine live which includes sawtimber and poletimbers, ponderosa pine dead which includes dead < 5 years and spruce-fir is combined with lodgepole materials.

Table IV-13 returns to stumpage, shows the total return distribution in each alternative by material class, enabling the observer to quickly note what amount, for example, of a total residual is due to dead and beetle-killed Ponderosa Pine.

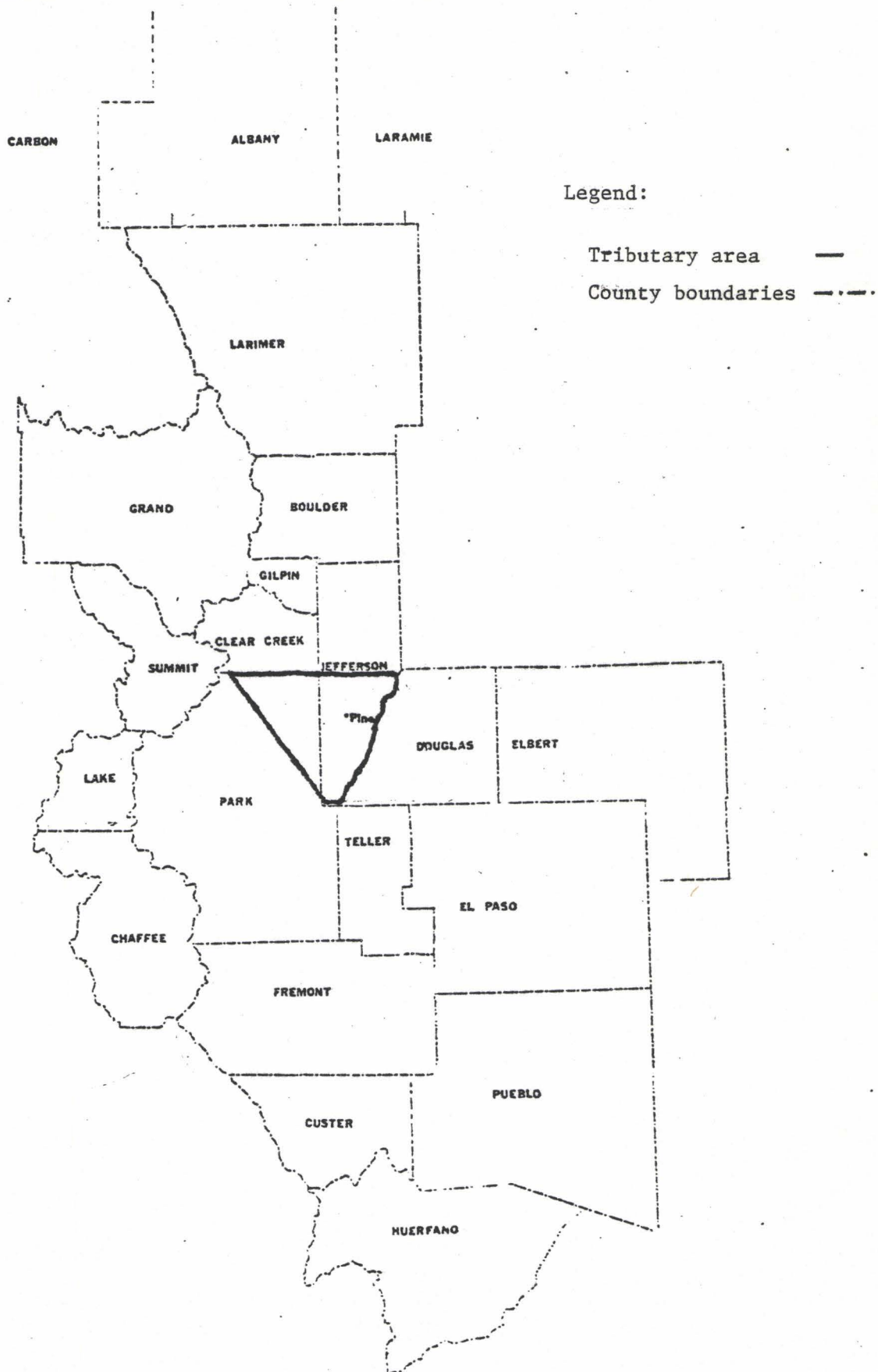
FIGURE IV-1 - Pine-Bailey Tributary Area

FIGURE IV-11 Pine-Bailey

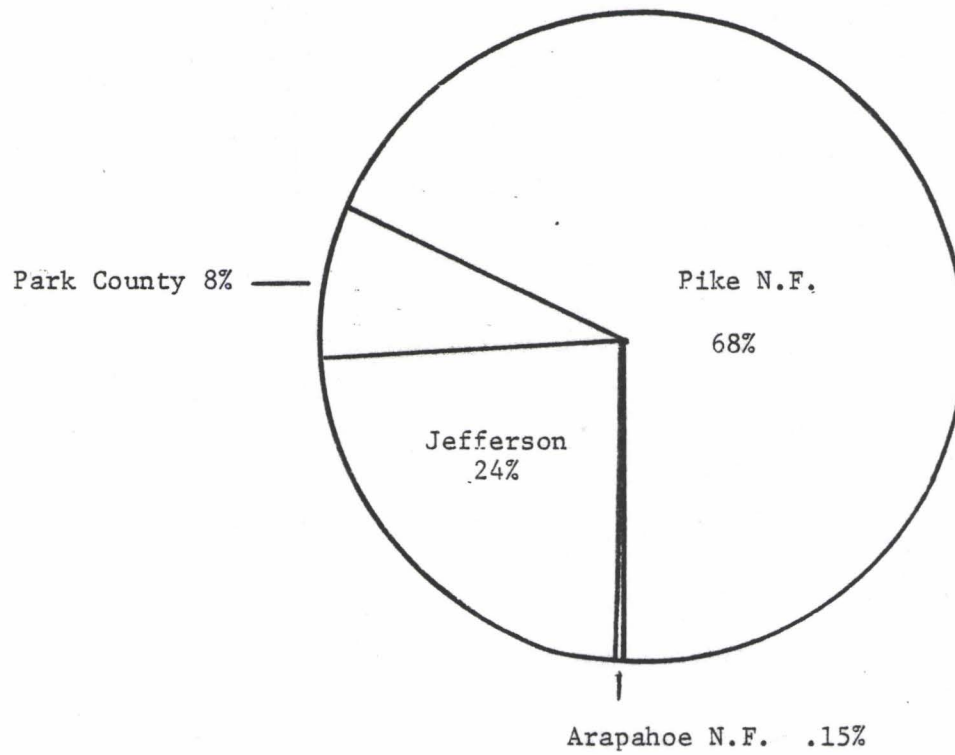
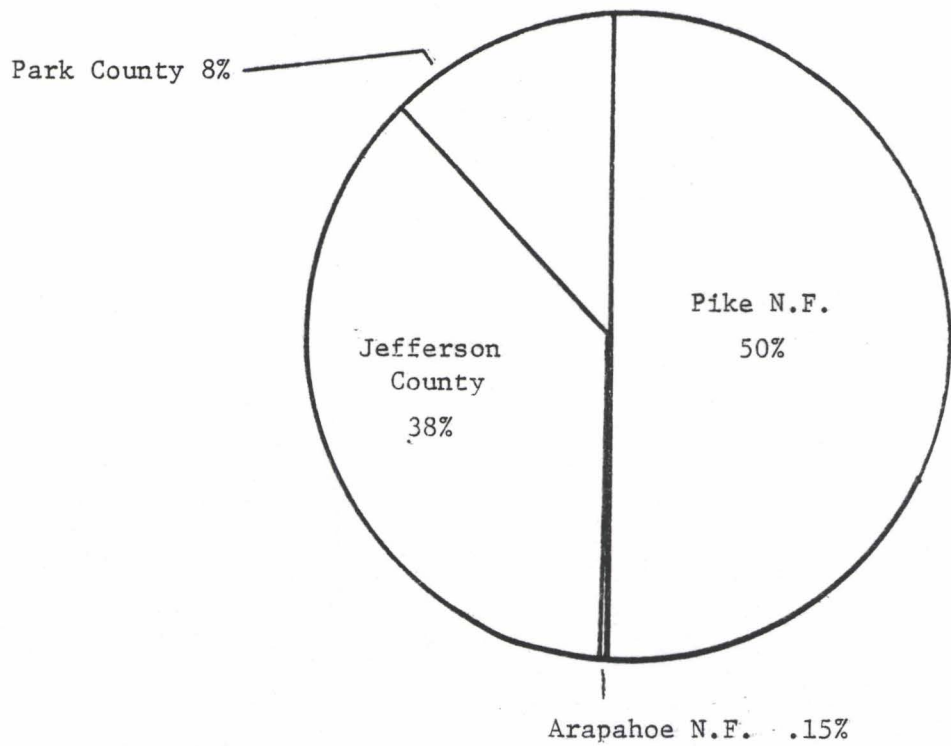
Timber Procurement AreaTotal Procurement AreaAccessible Commercial Area

TABLE IV-1 - Pine-Bailey

Timber Procurement AreaPROCUREMENT AREA:

Arapahoe National Forest:	532 acres
Pike National Forest:	260,265
Park County (state & private):	28,850
Jefferson County (state & private):	92,250
Total:	381,947 acres
(forested acres, at least 10% stocked)	

ACCESSIBLE COMMERCIAL FOREST LANDS - PROCUREMENT AREA:^{1/}

Arapahoe National forest:	291 acres
Pike National Forest:	96.954
Park County (state & private):	22,513
Jefferson County (state & private):	74,867
Total:	194,625 acres

^{1/} Standard and special component areas on national forest land,
all state and private lands.

TABLE IV-2 - Pine-Bailey
Raw Material Supply

Allowable Cut

Species	Size Class	bdft/cuft	allowable	bdft/cuft	product
Ponderosa pine	sawtimber	5 / 1	776 MCF	10/1	388 MCF
Ponderosa pine	poletimber	5 / 1	534	5/1	534
Spruce-fir	sawtimber	5 / 1	166	10/1	83
Spruce-fir	poletimber	5 / 1	144	5/1	144
Lodgepole	sawtimber	5 / 1	166	10/1	83
Lodgepole	poletimber	5 / 1	114	5/1	114

Current Cut

Species	Size Class	bdft/cuft	current	bdft/cuft	product
Ponderosa pine	sawtimber	5 / 1	158 MCF	10/1	79 MCF
Ponderosa pine	poletimber	5 / 1	39	5/1	39
Spruce-fir	sawtimber	5 / 1	34	10/1	17
Spruce-fir	poletimber	5 / 1	8	5/1	8
Lodgepole	sawtimber	5 / 1	34	10/1	17
Lodgepole	poletimber	5 / 1	8	5/1	8

Recommended Cut

Species	Size Class	bdft/cuft	recommend	bdft/cuft	product
Ponderosa pine	sawtimber	5 / 1	3,248 MCF	10/1	1,624
Ponderosa pine	poletimber	5 / 1	256	5/1	256
Ponderosa pine		5 / 1	695	8/1	427
(dead<5 yrs)					
Ponderosa pine		5 / 1	92	5/1	92
(dead>5 yrs)					

TABLE IV-3 - Pine-Bailey

Maximum Mill Production Capacity^{1/}

<u>Product</u>	<u>Output Capacity</u>	<u>Output Capacity</u>
Pallets	19.5 MCF of product	39.0 MCF of roundwood
Timbers	24.4	48.8
Rough boards	24.4	78.8
Planed boards	39.4	78.8
Barn poles	94.1	94.1
Fence posts	51.6	51.6
Houselogs	66.9	66.9
Paneling	98.4	160.2
Dimension lumber	58.6	117.2
Firewood	91.8	149.4
Beams	13.1	26.2
Chips	185.5	
Sawdust	90.7	
Shavings	63.7	

^{1/} based on an 8-hour day, 240 days/year

TABLE IV-4 - Pine-Bailey

Current Annual Product Production

<u>Product</u>	<u>Output</u>	<u>Output</u>
Pallets	19.5 MCF, of product	39.0 MCF of roundwood
Timbers	14.7	29.4
Rough boards	26.2	52.4
Planed boards	18.8	18.8
Fence posts	8.2	8.2
Houselogs	53.6	53.6
Paneling	65.6	106.8
Dimension lumber	58.6	117.2
Firewood	22.9	37.3
Beams	6.6	13.2
Chips	134.2	
Sawdust	65.5	
Shavings	38.1	

TABLE IV-5 - Pine-Bailey

Product Definition and Conversion Factors

Pallets	4'x4'	20 bdft/pallet	81.47 cuft/MBF
Timbers	6"x6"x8'		81.47 cuft/MBF
Rough boards	1"x4"		81.47 cuft/MBF
Planed boards	1"x4"		54.69 cuft/MBF
Barn poles	6"x20'	3.92 cuft/pole	treated
Fence posts	3.5"x6.5'	.43 cuft/post	treated
Houselogs	8"x16'	5.58 cuft/log	not tongue & grooved
Paneling	1"x4"		54.69 cuft/MBF
Dimension lumber	3"x6"		81.47 cuft/MBF
Firewood	4'x4'x8'	85 cuft/cord	
Beams	4"x4"x16'	1.76 cuft/beam	54.69 cuft/MBF
Chips		43 cuft/MBF, 25 lbs/cuft	
Sawdust		21 cuft/MBF	
Shavings		16 cuft/MBF	

TABLE IV-6 - Pine-Bailey

Alternative #1 Description

Constraints: - annual allowable cut on SF - LP
 - recommended PP cuts
 - annual cut on mortality PP and salable dead
 - product capacity for each product

Goals: #1 - minimize underachievement of recommended PP cuts
 #2 - maximization of returns to stumpage

Raw Material Supply (in MCF of roundwood):		Resources Used (in MCF of roundwood):
SF-LP Sawtimber	332.0	0.0
SF-LP poletimber	228.0	0.0
PP sawtimber	3248.0	358.8
PP poletimber	256.0	212.6
PP dead 5<yrs	695.0	309.6
PP dead 5>yrs	<u>92.0</u>	<u>0.0</u>
Total	4851.0 MCF	881.0 MCF

Maximum Mill Production Capacity
 (in MCF of roundwood):

pallets	39.0
timbers	48.8
roughboards	48.8
planed boards	78.8
houselogs	66.9
barn poles	94.1
fence posts	51.6
paneling	160.2
dimension lumber	117.2
firewood	149.4
beams	26.2

SF-LP = spruce-fir, lodgepole pine

PP = ponderosa pine

TABLE IV-7 - Pine-Bailey

Alternative #2 Description

Constraints: - annual allowable cut on SF, LP, PP
 - recommended annual cuts on mortality and salable dead

Goals: #1 - minimize underachievement of removing previous
 year PP mortality
 #2 - maximization of returns to stumpage

Raw Material Supply (in MCF of roundwood):		Resources Used (in MCF of roundwood)
SF-LP sawtimber	332.0	126.8
SF-LP poletimber	228.0	0.0
PP sawtimber	776.0	0.0
PP poletimber	534.0	0.0
PP dead 5<yrs	695.0	695.0
PP dead 5>yrs	<u>92.0</u>	<u>91.8</u>
Total	2657.0 MCF	913.6 MCF

Maximum Mill Production Capacity
 (in MCF of roundwood):

pallets	39.0
timbers	48.8
rough boards	48.8
planed boards	78.8
houselogs	66.9
barn poles	94.1
fence posts	51.6
paneling	160.2
dimension lumber	117.2
firewood	149.4
beams	26.2

TABLE IV-8 - Pine-Bailey

Alternative #3

Constraints: - annual allowable cuts on SF, LP, PP
 - recommended annual cut on mortality PP and salable dead

Goals: #1 - maximization of returns to stumpage

Raw Material Supply (MCF of roundwood):		Resources Used (MCF of roundwood):
SF-LP sawtimber	332.0	332.0
SF-LP poletimber	228.0	212.6
PP sawtimber	776.0	0.6
PP poletimber	534.0	0.0
PP dead 5<yrs	695.0	330.9
PP dead 5>yrs	<u>92.0</u>	<u>0.0</u>
Total	2657.0 MCF	875.5 MCF

Maximum Mill Production Capacity
(MCF of roundwood):

pallets	39.0
timbers	48.8
rough boards	48.8
planed boards	78.8
housetlogs	66.9
barn poles	94.1
fence posts	51.6
paneling	160.2
dimension lumber	117.2
firewood	149.4
beams	26.2

TABLE IV-9 - Pine-Bailey

Alternative #4 Description

Constraints: - current cut level for LP, SF, PP
 - recommended annual cut for mortality PP and salable dead
 - current annual production levels for each product

Goals: #1 - maximization of returns to stumpage

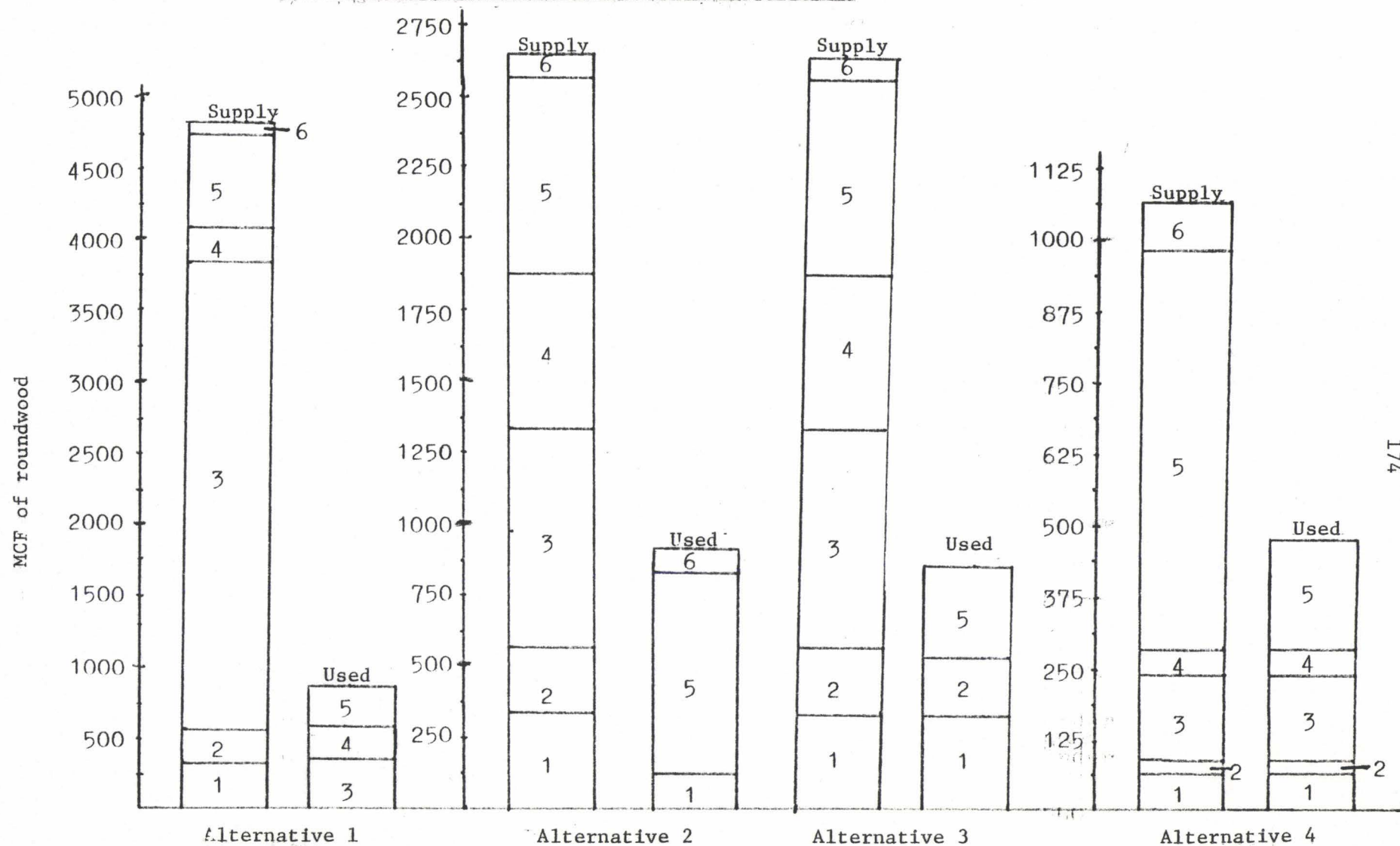
Raw Material Supply (MCF of roundwood):		Resources Used (MCF of roundwood):
SF-LP sawtimber	68.0	68.0
SF-LP poletimber	16.0	16.0
PP sawtimber	158.0	158.0
PP poletimber	39.0	39.0
PP dead 5<yrs	695.0	196.5
PP dead 5>yrs	<u>92.0</u>	<u>0.0</u>
Total	1068.0 MCF	477.5

Current Mill Production
(MCF of roundwood):

pallets	39.0
timbers	29.4
rough boards	29.4
planed boards	52.4
houselogs	53.6
barn poles	18.8
fence posts	8.2
paneling	106.8
dimension lumber	117.2
firewood	37.3
beams	13.2

TABLE IV-10 - Pine-Bailey

Raw Material Supply versus Raw Material Consumed



1 = Spruce-fir, lodgepole sawtimber
2 = Spruce-fir, lodgepole poletimber

3 = Ponderosa pine sawtimber
4 = Ponderosa pine poletimber

5 = Ponderosa, dead < 5 yrs
6 = Ponderosa, dead > 5 yrs

FIGURE IV-3 - Marketing Area for Pine-Bailey Processing Center

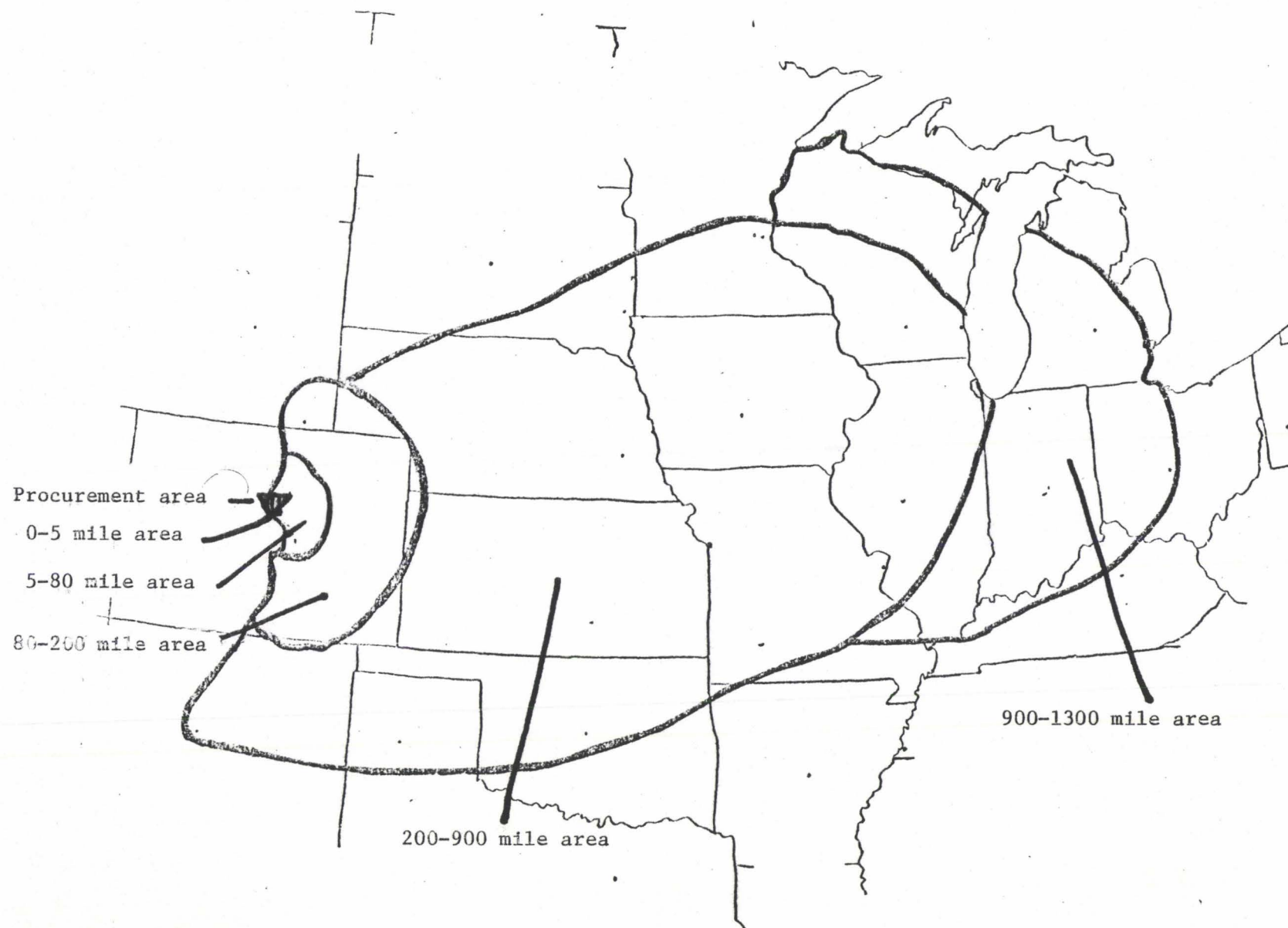


FIGURE IV-4 - Transportation Isocost Map and Marketing Area for Pine-Bailey

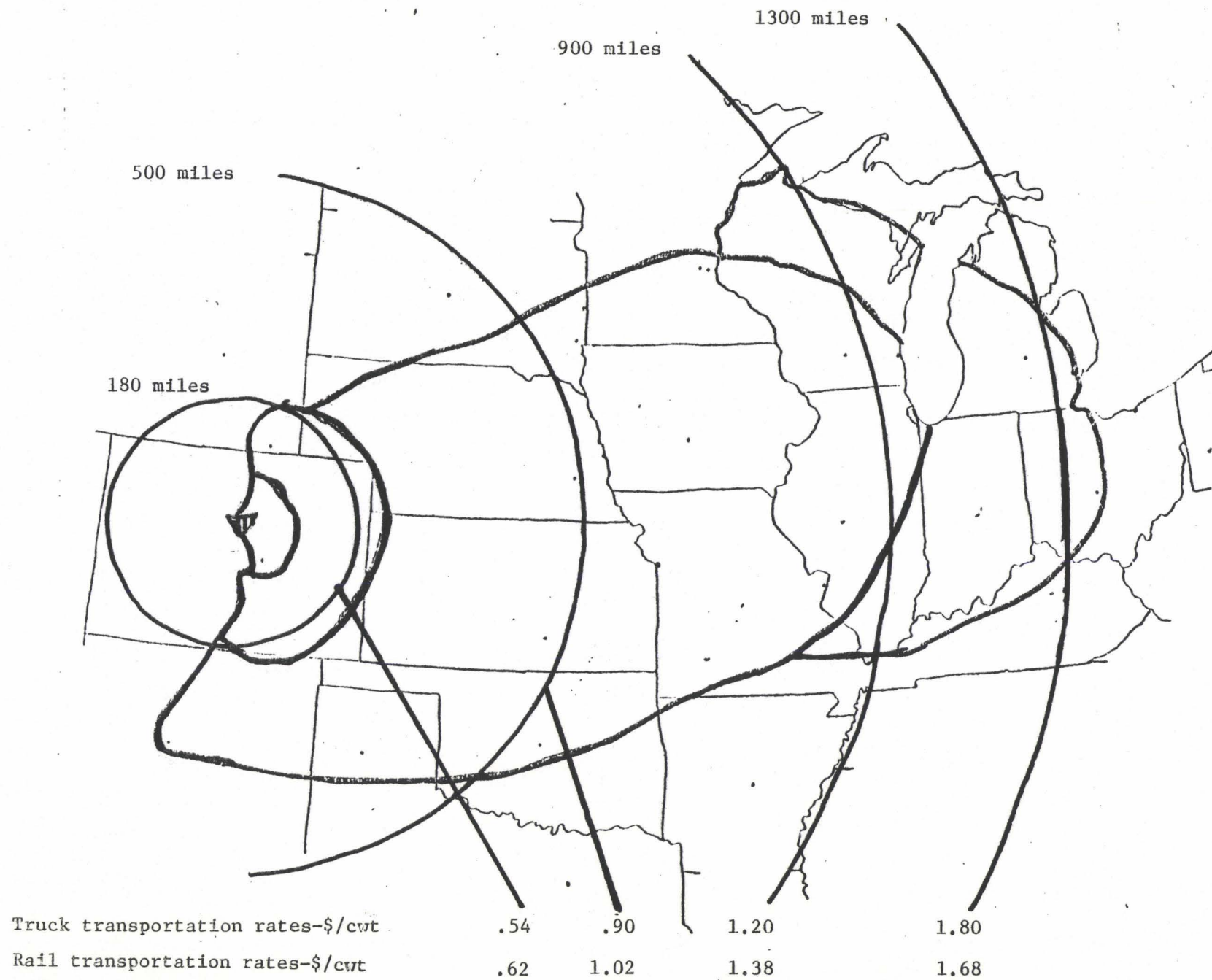


Table IV-11 Pine-Bailey

Market Consumption: Resources to Products (MCF of roundwood) - No Market Demand Restriction

	Alt. 1		Alt. 2		Alt. 3		Alt. 4	
0-5 Mile	pallets (PP)	39.0	pallets (D<5)	31.7	pallets (PP)	0.6	pallets (PP)	39.0
	timbers (PP)	48.8	timbers (D<5)	31.9	pallets (SFLP)	38.4	timbers (PP)	29.4
	boards r (PP)	48.8	timbers (SFLP)	9.6	timbers (SFLP)	48.8	boards r (PP)	13.8
	boards p (PP)	78.8	boards r (D<5)	39.7	boards r (SFLP)	48.8	boards r (SFLP)	15.6
	fence p (PP)	51.6	boards p (D<5)	64.1	fence p (SFLP)	51.6	fence p (D<5)	13.3
	dimension 1. (PP)	117.2	fence p (D<5)	84.0	dimension 1. (SFLP)	117.2	dimension 1. (PP)	75.8
	firewood (D<5)	149.4	dimension 1. (SFLP)	117.2	firewood (D<5)	149.4	firewood (D<5)	37.3
			firewood (D>5)	91.8				
5-80 Mile	houselogs (PP)	66.9	houselogs (D<5)	108.9	houselogs (SFLP)	66.9	houselogs (PP)	39.0
	barn p (PP)	94.1	barn p (D<5)	153.2	barn p (SFLP)	94.1	houselogs (SFLP)	14.6
	beams (PP)	26.2	beams (D<5)	21.3	beams (D<5)	21.3	barn p (D<5)	28.3
							barn p (SFLP)	1.4
200- 900 Mile	paneling (D<5)	160.2	paneling (D<5)	160.2	paneling (D<5)	160.2	beams (D<5)	10.7
					boards p (SFLP)	78.8	paneling (D<5)	106.8
900- 1300 Mile	chips	146.68	chips	146.68	chips	146.68	boards p (SFLP)	52.4
							chips	97.76

PP = Ponderosa Pine

SFLP = spruce-fir, lodgepole pine

D<5 = Ponderosa pine dead < 5 yrs

r = rough

p = planed; posts or poles

l. = lumber

D>5 = Ponderosa pine dead > 5 yrs

TABLE IV-12 - Pine-Bailey

Total Return Distribution Per Market Zone and Alternative

		0-5 Mile Area	5-80 Mile Area	200-900 Mile Area	900-1300 Mile Area
	Total Residual	\$104,538.70	\$63,212.60	\$208,509.60	440.04*
Alt.	Due to PP live	102,151.90	63,212.60	0.00	
1	Due to PP dead	2,386.80	0.00	208,509.60	
	Due to SFLP	0.00	0.00	0.00	
	Total Residual	\$ 95,510.40	\$61,030.10	\$208,509.60	440.04*
Alt.	Due to PP live	0.00	0.00	0.00	
2	Due to PP dead	91,987.20	61,030.10	208,509.60	
	Due to SFLP	3,523.20	0.00	0.00	
	Total Residual	\$ 93,854.70	\$74,876.10	\$242,827.00	440.04*
Alt.	Due to PP live	156.30	0.00	0.00	
3	Due to PP dead	2,386.80	9,261.70	208,509.60	
	Due to SFLP	91,311.60	65,614.40	34,317.40	
	Total Residual	\$ 25,359.20	\$26,555.00	\$116,826.60	293.37*
Alt.	Due to PP life	12,528.20	9,906.00	0.00	
4	Due to PP dead	11,575.20	11,591.40	139,006.40	
	Due to SFLP	1,255.80	5,057.60	22,820.20	

* represents return from chips.

TABLE IV-13 - Pine-Bailey

	<u>Returns to Stumpage</u> ^{1/}				Total Returns
	Returns due to live PP	Returns due to dead PP	Returns due to SFLP	Returns due to Residues	
Alternative #1	\$165,364.50	\$210,896.40	0.00	440.04	\$376,700.94
Alternative #2	0.00	361,526.90	3,523.00	440.04	\$365,490.14
Alternative #3	156.30	220,158.10	191,243.40	440.04	\$411,997.84
Alternative #4	22,434.20	162,173.00	29,133.60	293.36	\$214,034.16

^{1/} Returns to stumpage is the residual, i.e. the wholesale price less all production costs including a margin for profit and risk.

Table IV-14 - Pine-BaileyMills Marginal Revenues, Marginal Costs, Profit and Risk, and Residual

MR - MC - P&R = R*

MR (Wholesale Price)

MC (Stumpage Costs & Procurement Costs & Milling Costs & Transportation Costs to the Market)

P&R (10% of MC for Profit & Risk)

R (Residual)

* (When R is less than 0 the product is considered uneconomical to market in the marketing area)

Key

- 1) If there is no symbol in front of the product, it is currently marketed and is considered economical.
 - 2) * means the product is currently marketed and is considered uneconomical.
 - 3) ** means the product is not currently marketed, but is considered economical to market.
 - 4) *** means the product is not currently marketed, and is considered uneconomical.
-
- (PP) Ponderosa Pine
 - (LP) Lodgepole Pine
 - (SF) Spruce-Fir
 - (D<5) Ponderosa Pine that has been dead for five years or less.
 - Chips (D) = chips from dead wood
 - Chips (G) = chips from green wood

Table IV-14 - Pine-Bailey

0-5 Mile Marketing Area

<u>Products</u>	<u>MR/(MCF)</u>	<u>MC/(MCF)</u>	<u>P & R</u>	<u>Residual/(MCF)</u>
Pallets (PP)	3000	2254	225	521
Pallets (LP&SF)	3000	2212	221	567
Pallets (D<5)	3000	2278	228	494
Timbers (PP)	1920	1653	165	102
Timbers (LP&SF)	1920	1611	161	148
Timbers (D<5)	1920	1677	167	76
Boards R (PP)	1800	1532	153	115
Boards R (LP&SF)	1800	1490	149	161
Boards R (D<5)	1800	1556	156	88
Boards P (PP)	3657	2928	293	436
Boards P (LP&SF)	3840	2864	286	690
Boards P (D<5)	3474	2964	296	214
Barn Poles (PP)	3408	2758	276	374
Barn Poles (LP&SF)	3408	2716	272	420
Barn Poles (D<5)	3408	2794	279	335
Fence Posts (PP)	4069	2476	248	1345
Fence Posts (LP&SF)	4069	2465	246	1358
Fence Posts (D<5)	4069	2482	248	1339
Houselogs (PP)	1720	1377	138	205
Houselogs (LP&SF)	1720	1335	133	252
Houselogs (D<5)	1720	1413	141	166
Paneling (D<5)	5485	4390	439	656
Dimension L. (PP)	2400	2180	218	2
Dimension L. (LP&SF)	2400	2138	214	48
*Dimension L (D<5)	2400	2204	220	-24
Firewood (D<5)	588	511	51	26
Firewood (D<5)	588	523	52	13
Beams (PP)	3657	3065	306	286
Beams (LP) & (SF)	3657	3001	300	356
Beams (D<5)	4022	3101	310	611
*Chips (D)	28	42	4	-18
*Chips (C)	28	42	4	-18
*Shavings	28	42	4	-18
*Sawdust	28	42	4	-18

Table IV-14 (Cont'd)5-80 Mile Marketing Area

<u>Products</u>	<u>MR/(MCF)</u>	<u>MC/(MCF)</u>	<u>P & R</u>	<u>Residual/(MCF)</u>
Pallets (PP)	3000	2352	235	413
Pallets (LP&SF)	3000	2310	231	459
Pallets (D<5)	3000	2376	238	386
Timbers (PP)	1980	1746	175	59
Timbers (LP&SF)	1980	1704	170	106
Timbers (D<5)	1980	1770	177	33
***Boards R (PP)	1680	1584	158	-62
***Boards R (LP&SF)	1680	1542	154	-16
***Boards R (D<5)	1680	1608	161	-161
Boards P (PP)	3657	3007	300	350
Boards P (LP&SF)	3840	2943	294	603
Boards P (D<5)	3474	3043	304	127
Barn poles (PP)	3564	2842	284	438
Barn poles (LP&SF)	3564	2800	280	484
Barn poles (D<5)	3564	2878	288	398
Houselogs (PP)	1864	1464	146	254
Houselogs (LP&SF)	1864	1422	142	300
Houselogs (D<5)	1864	1500	150	214
Paneling (D<5)	6674	4449	445	1780
Fence posts (PP)	4069	2561	256	1252
Fence posts (LP&SF)	4069	2550	255	1264
Fence posts (D<5)	4069	2567	257	1245
***Dimension L (PP)	2400	2232	223	-55
***Dimension L (LP&SF)	2400	2190	219	-9
***Dimension L (D<5)	2400	2256	226	-82
***Firewood (D<5)	768	868	87	-187
***Firewood (D<5)	768	880	88	-200
Beams (PP)	3840	3144	314	382
Beams (LP&SF)	3840	3080	308	452
Beams (D<5)	4205	3180	318	707
*Chips (G&D)	37	138	14	-115
*Shavings	37	138	14	-115
*Sawdust	37	138	14	-115

80-200 Mile Marketing Area

**Pallets (PP)	3000	2537	254	209
**Pallets (LP&SF)	3000	2495	249	256
**Pallets (D<5)	3000	2561	256	183
**Timbers (PP)	2160	1874	187	99
**Timbers (LP&SF)	2160	1832	183	145
**Timbers (D<5)	2160	1898	190	72
**Boards P (PP)	3474	3093	809	72

Table IV-14 (Cont'd)

80-200 Mile Marketing Area (Cont'd)

<u>Products</u>	<u>MR/(MCF)</u>	<u>MC/(MCF)</u>	<u>P & R</u>	<u>Residual/(MCF)</u>
**Boards P (LP&SF)	3657	3029	303	325
***Boards P (D<5)	3388	3129	313	-54
**Barn poles (PP)	3360	3046	305	9
**Barn poles (LP&SF)	3360	3004	300	56
***Barn poles (D<5)	3360	3082	308	-30
**Fence posts (PP)	3720	2757	276	687
**Fence posts (D<5)	3720	2774	277	669
***Houselogs (PP)	1792	1653	165	-26
**Houselogs (LP&SF)	1792	1611	161	20
***Houselogs (D<5)	1792	1689	169	-66
**Paneling (D<5)	5485	4551	455	479
**Beams (PP)	3657	3230	323	104
**Beams (LP&SF)	3657	3166	317	174
**Beams (D<5)	4022	3266	327	429
***Boards R (All)	---	---	---	-(Very high)
***Dimension L (All)	---	---	---	-(Very high)
***Firewood (All)	---	---	---	-(Very high)
***Chips (All)	---	---	---	-(Very high)
***Shavings	---	---	---	-(Very high)
***Sawdust	---	---	---	-(Very high)

200-900 Mile Marketing Area

**Boards P (PP)	3657	3261	326	70
**Boards P (LP&SF)	4388	3197	320	871
***Boards P (D<5)	3474	3297	330	-153
**Fence P (PP)	4069	3602	360	107
**Fence P (LP&SF)	4069	3591	359	119
**Fence P (D<5)	4069	3608	361	100
**Beams (PP)	4022	3398	340	284
**Beams (LP&SF)	4022	3334	333	355
**Beams (D<5)	4388	3434	343	611
**Paneling (D<5)	7314	4723	472	2119
***Other Products	---	---	---	-(Very high)

900-1300 Mile Marketing Area

***Boards P (PP)	3657	3473	347	-163
**Boards P (LP&SF)	4388	3409	341	638
***Boards P (D<5)	3474	3509	351	-386
**Paneling (D<5)	7314	4935	494	1885
Beams (PP)	4022	3610	361	51
Beams (LP&SF)	4022	3546	355	121
Beams (D<5)	4388	3646	365	377
**Chips	244	219	22	3
***Other Products	---	---	---	-(Very high)

Table IV-15 Cost Breakdown Sheet for Pine-Bailey Processing Area

	Product	Stumpage ¹		Procurement		Milling		P & R %	Transp. (0-5)	Transp. (5-80)	Transp. (80-200)	Transp. (200-900)
		MBF	MCF	MBF	MCF	MBF	MCF		MCF	MCF	MCF	MCF
Not Treated	Pallets (PP)	3.00	36.00	64.51	774	119.99	1440	.10	4.00	102.45	286.88	-
	Pallets (LP)	4.00	48.00	60.01	720	"	"	"	"	"	"	-
	Pallets (SF)	"	"	"	"	"	"	"	"	"	"	-
	Pallets (D<5)	.50	6.00	69.00	828	"	"	"	"	"	"	-
	Timbers (PP)	3.00	36.00	64.51	774	70.00	840	.10	3.20	96.15	224.35	-
	Timbers (LP)	4.00	48.00	60.01	720	"	"	"	"	"	"	-
	Timbers (SF)	"	"	"	"	"	"	"	"	"	"	-
	Timbers (D<5)	.50	6.00	69.01	828	"	"	"	"	"	"	-
	Boards R (PP)	3.00	36.00	64.51	774	59.99	720	.10	1.80	54.00	-	-
	Boards R (LP)	4.00	48.00	60.01	720	"	"	"	"	"	-	-
	Boards R (SF)	"	"	"	"	"	"	"	"	"	-	-
	Boards R (D<5)	.50	6.00	69.01	828	"	"	"	"	"	-	-
	Boards P (PP)	3.00	54.85	64.51	1179	92.49	1691	.10	2.74	82.28	167.85	336
	Boards P (LP)	4.00	73.14	60.01	1097	"	"	"	"	"	"	"
	Boards P (SF)	"	"	"	"	"	"	"	"	"	"	"
	Boards P (D<5)	.50	9.14	69.01	1261	"	"	"	"	"	"	"
Not Tongue & Grooved	Barn Poles (PP)	2.00	24.00	64.51	774	163.09	1957	.10	3.18	86.95	291.39	-
	Barn Poles (LP)	3.00	36.00	60.01	720	"	"	"	"	"	"	-
	Barn Poles (SF)	"	"	"	"	"	"	"	"	"	"	-
	Barn Poles (D<5)	.50	6.00	69.01	828	"	"	"	"	"	"	-
	Fence Posts (PP)	2.00	24.00	41.37	496	162.73	1953	.10	3.22	88.06	295.14	1129
	Fence Posts (LP)	3.00	36.00	29.40	473	"	"	"	"	"	"	"
	Fence Posts (SF)	"	"	"	"	"	"	"	"	"	"	"
	Fence Posts (D<5)	.50	6.00	43.34	520	"	"	"	"	"	"	"
	Houselogs (PP)	2.00	24.00	64.51	774	48.00	576	.10	3.20	90.38	279.63	-
	Houselogs (LP)	3.00	36.00	60.01	720	"	"	"	"	"	"	-
	Houselogs (SF)	3.00	"	"	"	"	"	"	"	"	"	-
	Houselogs (D<5)	.50	6.00	69.01	828	"	"	"	"	"	"	-

¹ All figures are \$/MBF or \$/MCF as indicated² PRODUCT V - (product value) refers to the marginal revenue from each product in a given zone.

Transp. (900-1300) MCF	Product V ² (0-5) MBF MCF		Product V (5-80) MBF MCF		Product V (80-200) MBF MCF		Product V (200-900) MBF MCF		Product V (900-1300) MBF MCF	
-	250	3000	250	3000	250	3000	250	3000	-	-
-	"	"	"	"	"	"	"	"	-	-
-	"	"	"	"	"	"	"	"	-	-
-	"	"	"	"	"	"	"	"	-	-
-	160	1920	165	1980	180	2160	-	-	-	-
-	"	"	"	"	"	"	-	-	-	-
-	"	"	"	"	"	"	-	-	-	-
-	"	"	"	"	"	"	-	-	-	-
-	150	1800	140	1680	150	1800	-	-	-	-
-	"	"	"	"	"	"	-	-	-	-
-	"	"	"	"	"	"	-	-	-	-
-	"	"	"	"	"	"	-	-	-	-
548	200	3657	200	3657	190	3474	200	3657	240	4388
"	210	3840	210	2840	200	3657	240	4388		
"	"	"	"	"	"	"	"	"		
"	190	3474	190	3474	185	3388	190	3474		
-	284	3408	297	3564	280	3360	-	-	-	-
-	"	"	"	"	"	"	-	-	-	-
-	"	"	"	"	"	"	-	-	-	-
-	"	"	"	"	"	"	-	-	-	-
-	339	4069	339	4069	310	3720	339	4069	-	-
-	"	"	"	"	"	"	"	"	-	-
-	"	"	"	"	"	"	"	"	-	-
-	"	"	"	"	"	"	"	"	-	-
-	143	1720	155	1864	149	1792	-	-	-	-
-	"	"	"	"	"	"	-	-	-	-
-	"	"	"	"	"	"	-	-	-	-
-	"	"	"	"	"	"	-	-	-	-

Table IV-15 (Continued)

Product	Stumpage MBF MCF		Procurement MBF MCF		Milling MBF MCF		P & R %	Transp. (0-5) MCF	Transp. (5-80) MCF	Transp. (80-200) MCF	Transp. (200-900) MCF
Paneling (D<5)	.50	9.14	69.01	1261	170.49	3117	.10	2.74	61.65	164.40	336
Dimension L ³ (PP)	3.00	36.00	64.51	774	114	1368	.10	1.80	54.00	160.00	-
Dimension L (LP)	4.00	48.00	60.01	720	"	"	"	"	"	"	-
Dimension L (SF)	"	"	"	"	"	"	"	"	"	"	-
Dimension L (D<5)	.50	6.00	69.01	828	"	"	"	"	"	"	-
Firewood (D<5)	.50	6.00	40.58	487	0	0	.10	17.60	375	-	-
Firewood (D>5)	"	"	41.58	499	"	"	"	"	"	-	-
Beams (PP)	3.00	54.85	64.51	1179	100.0	1828	.10	2.74	82.28	167.85	336
Beams (LP)	4.00	73.14	60.01	1079	"	"	"	"	"	"	"
Beams (SF)	"	"	"	"	"	"	"	"	"	"	"
Beams (D<5)	.50	9.14	69.01	1261	"	"	"	"	"	"	"
Chips (O)	-	-	-	-	3.00	36.00	.10	5.81	101.74	349.00	-
Chips (G)	-	-	-	-	"	"	"	"	"	"	-
Shavings	-	-	-	-	3.00	36.00	.10	5.81	101.74	349	-
Sawdust	-	-	-	-	3.00	36.00	.10	5.81	101.74	349	-

³Dimension L = dimension lumber

Transp. (900-1300) MCF	Product V (0-5)		Product V (5-80)		Product V (80-200)		Product V (200-900)		Product V (900-1300)	
	MBF	MCF	MBF	MCF	MBF	MCF	MBF	MCF	MBF	MCF
548	300	5485	365	6674	300	5485	400	7314	400	7314
-	200	2400	200	2400	210	2520	-	-	-	-
-	"	"	"	"	"	"	-	-	-	-
-	"	"	"	"	"	"	-	-	-	-
-	"	"	"	"	"	"	-	-	-	-
-	49	588	64	768	49	588	-	-	-	-
-	"	"	"	"	"	"	-	-	-	-
548	200	3657	210	3840	200	3657	220	4022	220	4022
"	"	"	"	"	"	"	"	"	"	"
"	"	"	"	"	"	"	"	"	"	"
"	220	4022	230	4205	220	4022	240	4388	240	4388
183	-	28	-	37	-	187	-	-	-	244
"	-	28	-	37	-	187	-	-	-	244
-	-	28	-	37	-	187	-	-	-	-
-	-	28	-	37	-	187	-	-	-	-

CASE STUDY IV - PINE-BAILEY TRIBUTARY AREASummary AnalysisRaw Material Supply Versus Amount Consumed

As is shown in Tables IV-6, 7, 8, and 9, the raw material supply available in each alternative exceeded that consumed by as much as 2970 MCF.

Raw Material

Supply - Consumption Differential

Alternative 1	2	3	4
3970 MCF	1743.4 MCF	1781.5 MCF	590.5 MCF

Thus, a residual of raw material remains for each alternative including the fourth alternative which is based on current cut levels for spruce-fir, lodgepole pine, and ponderosa pine. Table IV-10 reveals that alternatives 2 and 3 have exactly the same supply in total and within each component of supply. Alternative 1 varies from this supply only in its increased amount of ponderosa pine sawtimber available, 3248 MCF. Ponderosa pine dead<5 years is the only raw material used throughout all the alternatives, and only in alternative 2 is it entirely consumed. This use, of course, follows the dictates of alternative 2's first goal of removing previous year mortality. Alternative 2 was also the only case to utilize any ponderosa pine dead>5 years.

Utilization of Ponderosa Pine Types

Alternative 1, in response to its use of recommended ponderosa pine cuts and its primary goal of utilizing ponderosa pine has both the largest supply and utilization rate of all the alternatives as listed below.

Alternative	1	2	3	4	
Ponderosa Pine Supply	4291	2097	2097	984	MCF
Ponderosa Pine Used	880.0	787	331.5	393.5	MCF

Alternatives 2 and 3 supply, based on allowable cut, readily shows the increased level of potential supply between allowable cut and the recommended cut on ponderosa pine.

Utilization of Beetle-Killed Ponderosa Pine

Alternative	1	2	3	4	
Beetle-killed ponderosa pine supply	787	787	787	787	MCF
Beetle-killed ponderosa pine used	309.6	787	330.9	196.5	MCF

The table above summarizes by alternative the beetle-killed ponderosa pine available for supply and that consumed. As was reported earlier, alternative 2 consumed the largest quantity of this material, equal to supply. Alternative 4 consumed the least amount of beetle-killed wood regardless of the fact that it had an equivalent supply. Due to a restricted production capacity, products produced were made from those materials which yielded the highest return in its finished state. Products in alternative 4 which were made from beetle-kill pine include fence posts, barn poles, beams and paneling. Alternative 2, with the largest utilization of beetle-kill pine also had the largest range of products produced from beetle-kill; almost every product produced in the Pine-Bailey processing area was made from beetle-kill material. Those products made

from beetle-killed pine common to alternatives 1 and 3 firewood and paneling.

Overall Returns to Stumpage

Alternative	1	2	3	4
Ponderosa Pine as % of Total Supply	88.4	79.0	79.0	92.1
Ponderosa Pine as % of Total Used	100	86.2	37.9	82.4
Revenue as a % of Total	99.8	98.9	53.5	86.3
Spruce-Fir, Lodgepole Pine as a % of Total Supply	11.6	21.0	21.0	7.9
Spruce-Fir, Lodgepole Pine as a % of Total Used	0	13.8	62.1	17.6
Revenue as a % of Total	0	.9	46.4	13.6
TOTAL REVENUE	\$376,700	365,490	411,997	214,034

*Residual figures include revenue or residual due to mill residue.

Because of the priority goal stipulating use of ponderosa pine in alternative 1, ponderosa pine represented a very high proportion of material and 100% of total revenue. In alternative 3, ponderosa pine represented 79% of supply but accounted for only 53.5% of total revenue. This was the result of utilizing spruce fir and lodgepole pine first as products from this material have the greatest return. As a result, ponderosa was used for less profitable product lines. Spruce-fir, lodgepole pine supply percentages are the same in alternatives 2 and 3 but their contribution to total revenue vary drastically. Alternative 2 consumes ponderosa pine initially, in response to its first goal, and in the form of high value products in response to its second goal of maximizing returns. Alternative 3, with the largest percentage component of spruce-fir, lodgepole used also yields the highest total revenue. This serves to

illustrate the prospects of high return in conjunction with ponderosa pine beetle-killed wood production.

Market Consumption of Products

Lacking demand restrictions, the program will attempt to market products to marketing zones where the greatest potential for return exists. Because maximization of returns to stumpage is a goal for each of the four alternatives, the residuals each product line can return become important to the consumption pattern of products from the processing center. Table IV-11 exhibits this consumption pattern by alternative. Products produced are generally found listed in that market zone which returns the highest residual, within the constraints and goals of each alternative. Those products marketed at increasing distances from the processing center have a high enough marginal revenue to produce positive residuals even with the added transportation costs. (See Table IV-14). In this case, no product is marketed beyond 900 miles.

General Consumption Breakdown

The consumption of products in marketing zones from the processing center follows the model suggested below (when given no demand constraints).

0-5 mile:	pallets	200-900	paneling
	timbers		planed boards
	boards	900-1300:	chips
	fence posts		
	dimension lumber		
	firewood		
5-80 mile:	houselogs		
	barn poles		
	beams		

Optimum Ponderosa Pine Utilization

Alternatives 1 and 2 utilize the greatest amount of ponderosa pine of the four alternatives, due primarily to their goals. From tables displayed in the preceding few pages, a comparison between ponderosa pine consumed and beetle-killed pine can be made.

Alternative	1	2	3	4	
Total Ponderosa Pine Used	880.0	787	331.5	393.5	MCF
Total Beetle-Killed Pine Used	309.6	787	330.9	196.5	MCF
Total Revenue as a % due to PP	99.8	99.8	53.5	86.3	

From examination of the table, it appears clear that the highest overall rate of utilization and return can be obtained from a combination of the goals in alternatives 1 and 2. Both of these alternatives return high total revenue while actively using ponderosa pine and beetle-killed ponderosa pine. In terms of remaining supply alternative 1 possesses a high supply of both ponderosa pine and beetle-kill pine which may serve to encourage expanded product rates of products from these materials.

Product Profit Potentials

Listed below are those products which are currently not marketed in some marketing zones but do hold profit potentials worth investigation. (See Table IV-14 and 15.)

80-200 mile zone:

<u>Products</u>	<u>Residuals or Returns to Stumpage (\$/MCF of roundwood)</u>
Pallets - PP	104.50
Pallets - SFLP	128.00
Pallets - D<5	92.50
Timbers - PP	49.50
Timbers - SFLP	74.50
Timbers - D<5	36.00
Boards p - PP	36.00
Boards p - SFLP	162.50
Barn poles - PP	9.00
Barn poles - SFLP	56.00
Fence posts - PP	675
Fence posts - SFLP	687
Fence posts - D<5	669
Houselogs - SFLP	20.00
Paneling - D<5	294.63
Beams - PP	52.00
Beams - SFLP	87.00
Beams - D<5	214.50

200-900 mile zone:

<u>Products</u>	Returns to Stumpage (\$/MCF of roundwood)
Boards, planed - PP	35.00
Boards, planed - SFLP	435.50
Fence posts - PP	107.00
Fence posts - SFLP	119.00
Fence posts - D<5	100.00
Beams - PP	142.00
Beams - SFLP	177.50
Beams - D<5	305.50
Paneling - D<5	1303.37

900-1300 mile zone:

<u>Products</u>	Returns to Stumpage (\$/MCF of roundwood)
Boards, planed - SFLP	319.00
Paneling - D<5	1159.44
Chips	3.00

There are several products which, through the investigation of this study, have been found to be economic losses even though they are presently marketed in the zones suggested. Dimension lumber made from beetle-killed wood dead<5 years is shown to have a residual of -\$24.00 in the 0-5 mile area. The product shows higher losses are probable at greater distances and it presently is not marketed beyond the first zone. Any combination of product-species type currently returning a negative residual was not included in the goal program. Chips, shavings, and sawdust are also found to be marketed at a loss in the local, 0-5 zone, as well as in the 5-80 mile zone due to low product values in relation to costs.

Pine-Bailey Tributary Area

Sensitivity Analysis

Table IV-16 depicts the level of usage of raw material for each of the alternatives in the sensitivity analyses for the Pine-Bailey center. The resources used in each alternative was far below that supply available. As compared to the original alternative runs presented earlier in Tables IV-6, 7, 8 and 9, the resource utilization was less in the sensitivity test than in the original alternatives. (See Table IV-16)

Resources Used (MCF of roundwood)

Alternative	1	2	3	4	
Original Analysis	881	913	875	477	MCF
Sensitivity Analysis	597	694	592	353	MCF

This drop is the result of the imposition of a 10% demand limitation and the marginal analysis of products which determined their positive or negative residual value. This marginal analysis showed some products to be uneconomical to market in certain zones due to a negative residual. Those products with this negative residual were excluded from possible marketing in that zone. Some products which had positive returns in the first zone, 0-5 miles, but had negative values at greater distances were then restricted to 10% of their original consumption level. In this case the products most affected by the consumption or demand restriction were firewood, rough boards, and dimension lumber. Comparison of Tables IV-11 and 20 indicates this result.

Table IV-16 - Pine-Bailey: SENSITIVITY STUDY
Raw Material Supplies Versus Raw Material Used

Alternative 1

Supply (MCF of roundwood)		Resources Used (MCF of roundwood):
SFLP sawtimber	332.0	0.0
SFLP poletimber	228.0	0.0
PP sawtimber	3248.0	209.4
PP poletimber	256.0	212.6
PP dead 5<yrs	695.0	175.1
PP dead 5>yrs	<u>92.0</u>	<u>0.0</u>
TOTAL	4851.0 MCF	597.1 MCF

Alternative 2

Supply (MCF of roundwood)		Resources Used (MCF of roundwood):
SFLP sawtimber	332.0	11.8
SFLP poletimber	228.0	0.0
PP sawtimber	776.0	0.0
PP poletimber	534.0	0.0
PP dead 5<yrs	695.0	682.0
PP dead 5>yrs	<u>92.0</u>	<u>0.0</u>
TOTAL	2657.0 MCF	693.8 MCF

Alternative 3

Supply (MCF of roundwood)		Resources Used (MCF of roundwood):
SFLP sawtimber	332.0	183.2
SFLP poletimber	228.0	212.6
PP sawtimber	776.0	0.0
PP poletimber	534.0	0.0
PP dead 5<yrs	695.0	196.5
PP dead 5>yrs	<u>92.0</u>	<u>0.0</u>
TOTAL	2657.0 MCF	592.3 MCF

Alternative 4

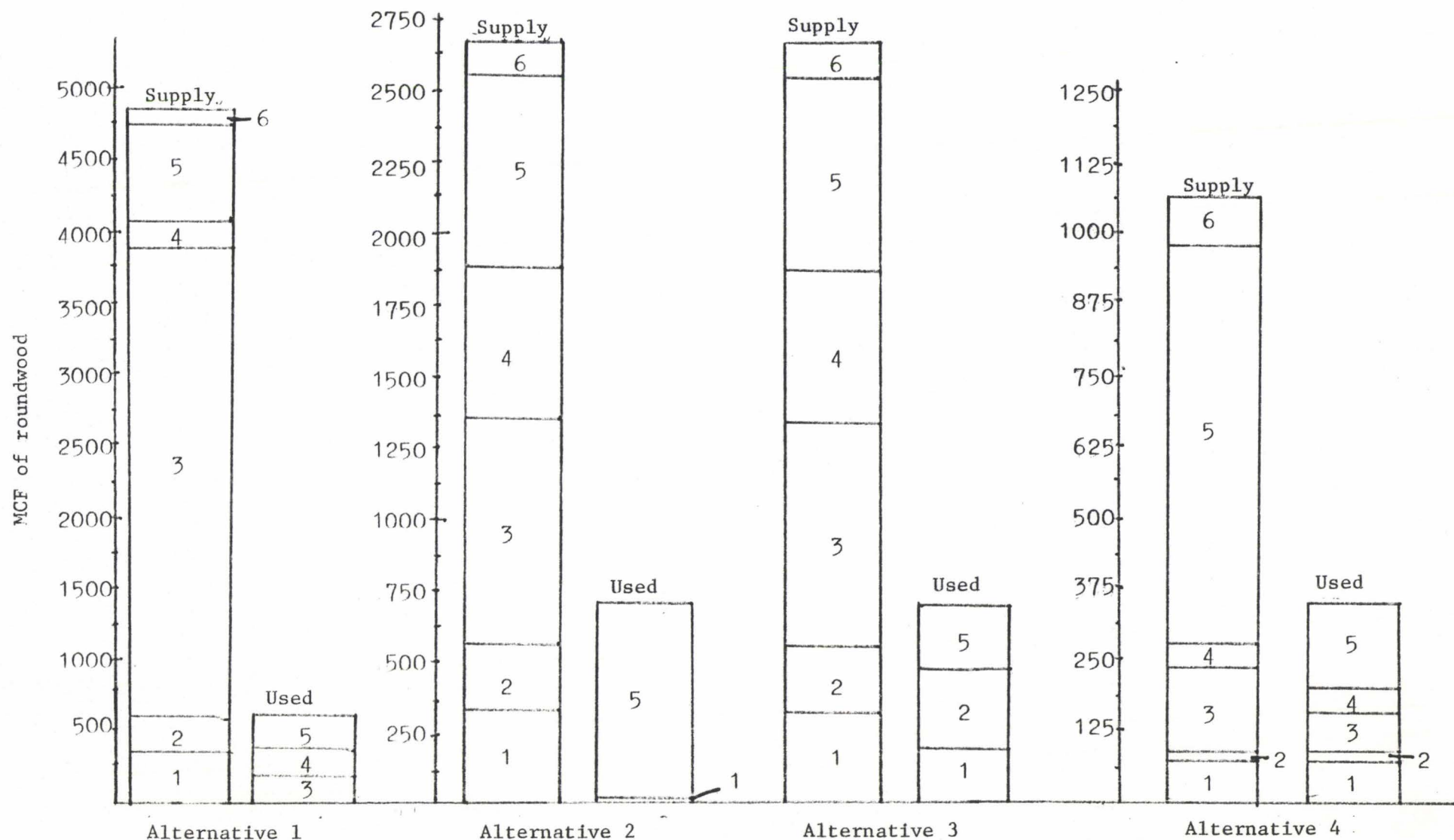
Supply (MCF of roundwood)

Resources Used
(MCF of roundwood):

SFLP sawtimber	68.0	68.0
SFLP poletimber	16.0	16.0
PP sawtimber	158.0	67.6
PP poletimber	39.0	39.0
PP dead 5<yrs	695.0	162.9
PP dead 5>yrs	<u>92.0</u>	<u>0.0</u>
TOTAL	1068.0 MCF	353.5 MCF

TABLE IV-17 - Pine-Bailey: SENSITIVITY STUDY

Raw Material Supply Versus Raw Material Consumed



1=spruce-fir, lodgepole sawtimber
2=spruce-fir, lodgepole poletimber

3=ponderosa pine sawtimber
4=ponderosa pine poletimber

5=ponderosa, dead 5<yrs
6=ponderosa, dead 5>yrs

The table below reveals the difference in raw material use by species type between the original alternatives and the sensitivity alternatives.

Raw Material Used - Original Alternatives Versus Sensitivity Analysis
(MCF of roundwood)

	Alt. 1- Alt. 1-S	Alt. 2- Alt. 2-S	Alt. 3- Alt. 3-S	Alt. 4- Alt. 4-S
SFLP sawtimber	0.0	115.0	148.8	0.0
SFLP poletimber	0.0	0.0	0.0	0.0
PP sawtimber	149.4	0.0	0.0	90.4
PP poletimber	0.0	0.0	0.0	0.0
PP dead<5 yrs	134.5	13.0	134.4	33.6
PP dead>5 yrs	0.0	91.8	0.0	0.0

* Alt. 1-S refers to the sensitivity analysis program run using alternative 1 constraints and goals outlined in Tables IV-6, 7, 8, and 9.

Due to this lower level of raw material utilization and resulting consumption, the level of returns to stumpage was lower for each sensitivity alternative. This is also due to, in some cases, a lower return on products which were originally consumed in the 0-5 mile zone, but now due to the limitation are consumed at greater distances from the center at lower residuals rates. For example in alternative 1 (original program run) 39 MCF of ponderosa pine pallets were consumed in the first marketing zone with a residual of \$521/MCF (See Table IV-11). In the sensitivity analysis 4 MCF of ponderosa pine pallets were marketed in the first zone with a residual of \$521/MCF and the remaining ponderosa pine pallets (90%) were marketed in the second zone, 5-80 miles, with a residual of \$413/MCF.

Tables IV-18 and 19 reveals total returns to stumpage and the distribution of these returns which may be compared to Tables IV-12 and 13. The chart below uses data from the two tables mentioned above.

Difference in Returns to Stumpage - Original Alternative minus Sensitivity
Alternative

	0-5 Mile	50-80 Mile	80- 200 Mile	200- 900 Mile	900- 1300 Mile	Total Differ- ence
Alt. 1-Alt. 1-S	\$94,030	-77,745	-2178	0.00	118	14,225
Alt. 2-Alt. 2-S	85,809	-69,031	-1584	0.00	118	15,312
Alt. 3-Alt. 3-S	84,359	-66,682	-3190	0.00	118	14,604
Alt. 4-Alt. 4-S	22,614	-16,537	-1306	0.00	71	4,836

As a result of the demand constraint the zones in which certain products were consumed may have been altered. Due to the constraint more MCF of product would be sold at a greater distance from the center as depicted in the table below.

General Product Consumption BreakdownOriginal Alternative/Sensitivity

0-5 mile zone:

pallets	pallets
timbers	timbers
boards	boards
fence posts	fence posts
dimension lumber	dimension lumber
firewood	firewood

5-80 mile zone:

houselogs	houselogs
barn poles	barn poles
beams	beams
	pallets
	boards
	fence posts

Original Alternative/Sensitivity

80-200 mile zone: timbers

200-900 mile zone:

paneling	paneling
planed boards	planed boards

900-1300 mile zone:

chips	chips
-------	-------

Exact amounts of these products consumed are listed in Tables IV-11 and 20.

Table IV-18 - Pine-Bailey: SENSITIVITY STUDY
Total Return Distribution per Market Zone and Alternative

Alternative		0-5 mile zone	5-80 mile zone	80-200 mile zone	200-900 mile zone	900-1300 mile zone
1	Total returns	\$10,508.20	140,957.90	2178.00	208,509.00	321.71*
	Due to PP live	10,269.00	140,957.90	2178.00	0.00	
	Due to PP dead	239.20	0.00	0.00	208,509.00	
	Due to SFLP	0.00	0.00	0.00	0.00	
2	Total returns	9,701.40	130,061.60	1584.00	208,509.60	321.71*
	Due to PP live	0.00	0.00	0.00	0.00	
	Due to PP dead	9,418.20	130,061.60	1584.00	208,509.60	
	Due to SFLP	283.20	0.00	0.00	0.00	
3	Total returns	9,459.60	141,558.20	3190.00	242,827.00	321.71*
	Due to PP live	0.00	0.00	0.00	0.00	
	Due to PP dead	239.20	9,261.70	0.00	208,509.60	
	Due to SFLP	9,220.40	132,296.50	3190.00	34,317.40	
4	Total returns	2,745.10	43,092.30	1306.80	161,826.60	221.76*
	Due to PP live	1,087.80	15,773.90	1306.80	0.00	
	Due to PP dead	59.80	21,122.80	0.00	139,006.40	
	Due to SFLP	1,597.50	6,195.00	0.00	22,820.20	

* Returns due to residues.

TABLE IV-19 - Pine-Bailey: SENSITIVITY STUDY

Returns to Stumpage

Alternative	Revenue due to Ponderosa Pine	Revenue due to dead Ponderosa Pine	Revenue due to Spruce fir-lodgepole	Revenue due to mill residue	Total Revenue
1	\$153,404.90	208,748.80	0.00	321.72	\$362,475.41
2	0.00	349,573.40	283.20	321.71	350,178.31
3	0.00	218,010.50	179,024.30	321.72	397,356.52
4	18,168.50	160,189.00	30,613.30	221.76	209,192.56

Table IV-20 - Pine-Bailey: SENSITIVITY STUDY

Market Consumption: Resources to Products (MCF of roundwood)

	Alternative 1		2		3		4	
0-5 mile zone	Pallets (PP)	4.0	Pallets (D 5)	3.2	Pallets (SFLP)	4.0	Pallets (SFLP)	4.0
	Timbers (PP)	4.8	Timbers (D 5)	3.9	Timbers (SFLP)	4.8	Timbers (SFLP)	3.0
	Boards R (PP)	4.8	Boards R (D 5)	3.9	Boards R (SFLP)	4.8	Boards R (SFLP)	3.0
	Boards P (PP)	7.8	Boards P (D 5)	6.3				
	Fence P (PP)	5.2	Fence P (D 5)	8.5	Fence P (SFLP)	5.2	Fence P (PP)	0.8
	Dimension L (PP)	11.8	Dimension L (SFLP)	11.8	Dimension L (SFLP)	11.8	Dimension L. (PP)	11.8
	Firewood (D<5)	15.0	Firewood (D<5)	15.0	Firewood (D<5)	15.0	Firewood (D<5)	3.7
5-80 mile zone	Pallets (PP)	35.0	Pallets (D<5)	28.5	Pallets (SFLP)	35.0	Pallets (PP)	29.4
	Boards P (PP)	71.0	Boards P (D<5)	57.8			Pallets (SFLP)	5.6
	Houselogs (PP)	66.9	Houselogs (D<5)	108.9	Houselogs (SFLP)	66.9	Houselogs (PP)	38.2
	Barn P (PP)	94.1	Barn P (D<5)	153.2	Barn P (SFLP)	94.1	Houselogs (SFLP)	15.4
	Fence P (PP)	46.4	Fence P (D<5)	75.5	Fence P (SFLP)	46.4	Barn P (D<5)	18.2
	Beams (PP)	26.2	Beams (D<5)	21.3	Beams (D<5)	21.3	Barn P (SFLP)	0.6
							Fence P (D<5)	7.4
80-200 mile zone							Beams (D<5)	10.7
	Timbers (PP)	44.0	Timbers (D<5)	35.8	Timbers (SFLP)	44.0	Timbers (PP)	26.4
200-900 mile zone	Paneling (D<5)	160.2	Paneling (D<5)	160.2	Boards P (SFLP)	78.8	Boards P (SFLP)	52.4
					Paneling (D<5)	160.2	Paneling (D<5)	106.8
900- 1300 mile zone	Chips*	107.24	Chips*	107.24	Chips*	107.24	Chips*	73.92

*Value for chips is in terms of product, not roundwood

CASE STUDY V: Colorado Springs Case Study

The Colorado Springs Case Study has a timber procurement and base of over 1,180,000 acres. This procurement acreage was developed in CSU Report #2192. As detailed earlier in this report the procurement zone encompasses areas of present or potential supply for area mills. To avoid the complexity of overlapping procurement areas between processing centers, the center holding a competitive advantage was considered to be the key buying center. The Colorado Springs procurement area encompasses state and private lands in Summit and Teller Counties and portions of Park, Douglas, El Paso and Elbert Counties as well as parts of the Pike, Arapaho and San Isabel National Forests. Figure V-1 illustrates as a percentage the ownership portions encompassing the procurement area as well as accessible acreage within these areas. Table V-1 lists acreage totals for each ownership.

The timber supply in terms of allowable cut, current cut and recommended annual cut were obtained from CSU Project #2192. The raw material supply, as displayed in Table V-2 illustrates the conversion of logs to products.

The four alternative descriptions, Tables V-6, 9, for this case study will display the individual input values to represent the four sets of overriding goals. The constraints would represent types and levels at timber cut per species and mill capacities for various products with a standard profit per product for all alternatives.

Production capability is shown in Table V-3, with Table V-4 displaying current annual production for area mills. A definition of the products produced in the Colorado Springs center and their respective conversion factors is shown in Table V-5. This table displays the product standard finished size, the amount of wood per product and, in appropriate cases, a conversion from cubic feet of products to board feet.

The results of implementing each alternative are individually briefed in Tables V-6 through V-9. The tables show the constraints and goals for each goal program run. Raw material supply as well as product capacity, reflective of the above constraints are also shown.

Resources used from different material classes are also displayed adjacent to raw material available in the form of percentages in Table V-10. Thus, by examining the output strictly in terms of supply the observer may determine the impact of a certain alternative strategy on the consumption of a certain size and species class of timber relative to the others.

The total amount of each material class is broken down into ultimate products in Table V-11. The total revenue (residual) due to the allocation of raw materials to given products is illustrated in Table V-12. The table shows values for given numbers of products sold in a market area by raw material class. The material classes here are grouped into ponderosa pine live and includes both sawtimber and poletimber. Ponderosa pine dead includes dead < 5 years and spruce-fir and lodgepole materials are also grouped.

Table V-13, returns to stumpage, shows the total profit distribution in each alternative by material class, enabling the observer to quickly note what amount, for example, of a total profit is due to dead and live ponderosa pine.

FIGURE V-1 Colorado Springs Tributary Area

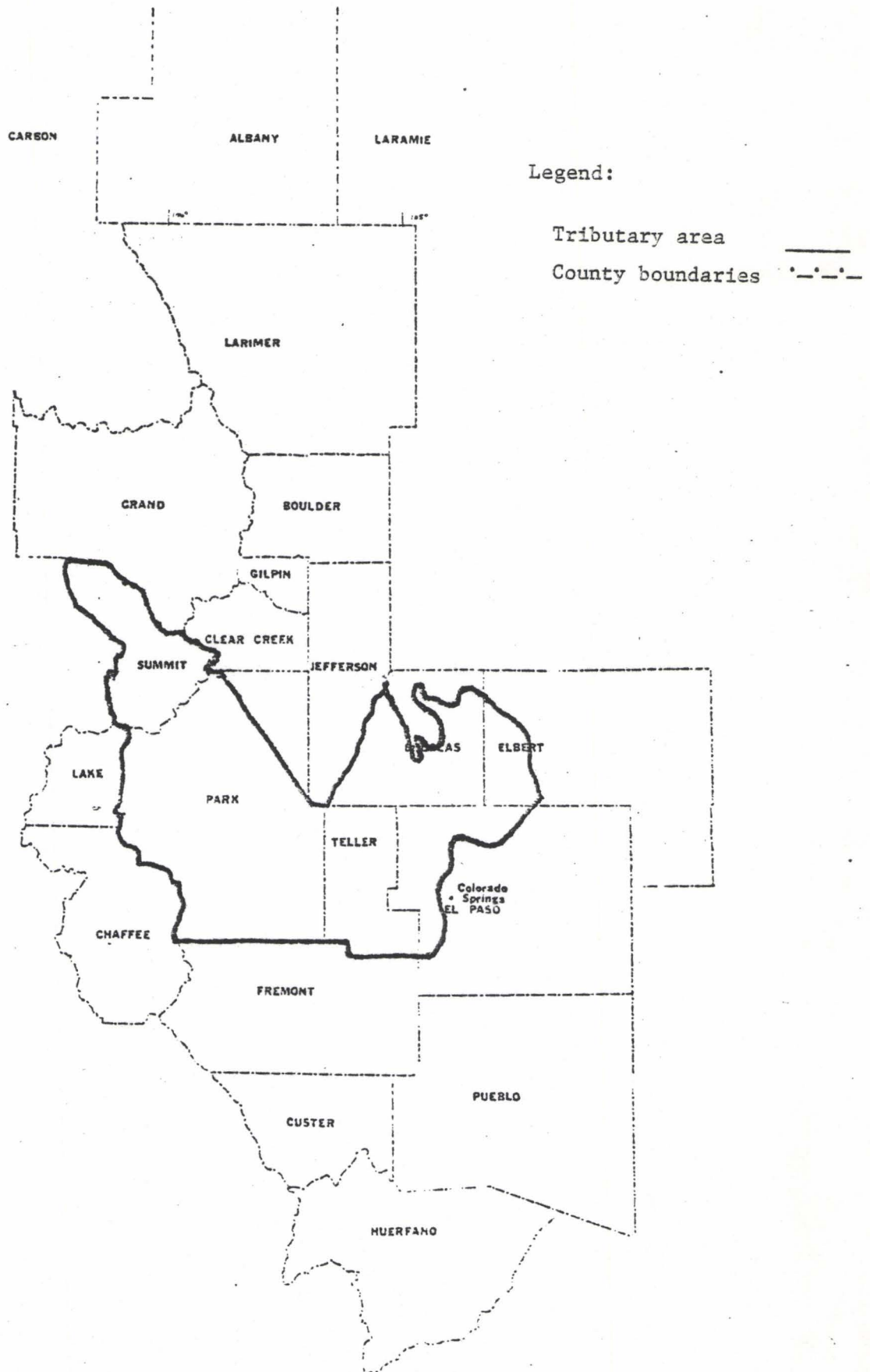
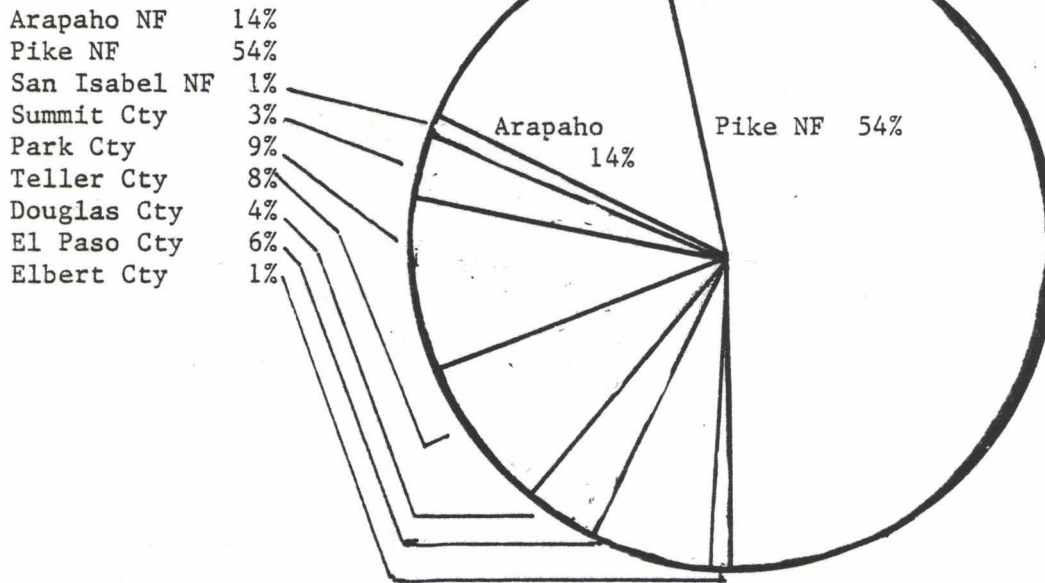


FIGURE V-11

Colorado Springs-Timber Procurement Area

Total Procurement Area



Accessible Commercial Area

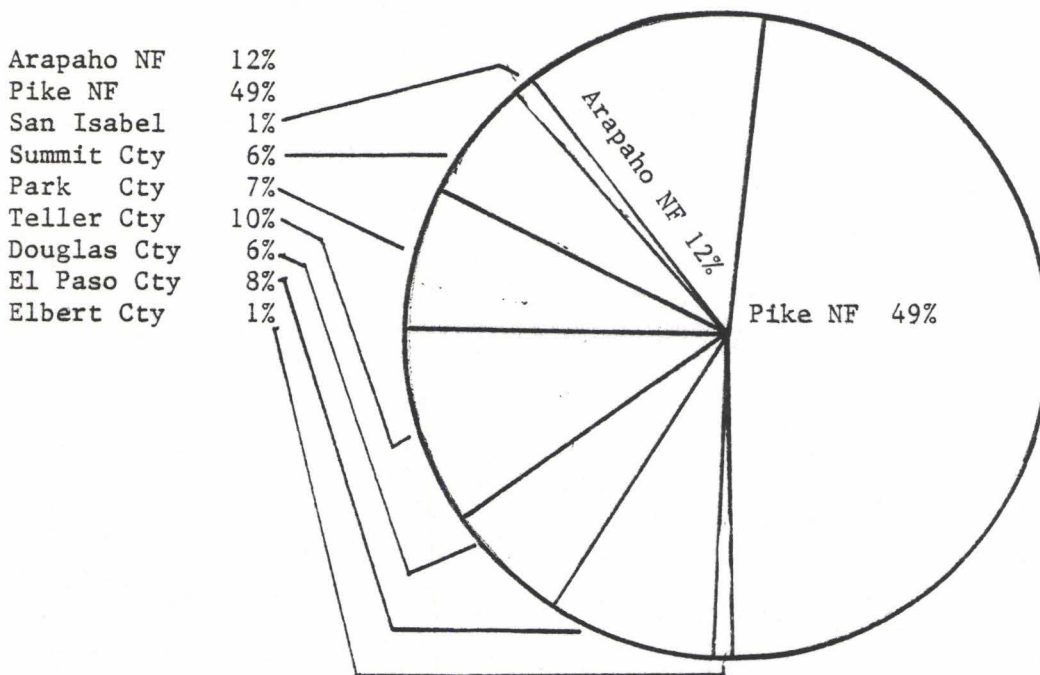


TABLE V-1 - Colorado Springs

Timber Procurement AreaPROCUREMENT AREA:

Arapaho National Forest:	160,600 acres
Pike National Forest:	632,957
San Isabel National Forest:	17,120
Summit County (state & private):	37,200
Park County (state & private):	110,350
Teller County (state & private)	91,790
Douglas County (state & private)	48,600
El Paso County (state & private):	75,600
Elbert County (state & private):	6,000

Total: 1,180,217 acres

(forested acres, at least 10% stocked)

ACCESSIBLE COMMERCIAL FOREST LANDS - PROCUREMENT AREA:^{1/}

Arapaho National Forest:	68,994 acres
Pike National Forest:	285,083
San Isabel National Forest:	4,675
Summit County (state & private):	35,300
Park County (state & private):	42,087
Teller County (state & private):	60,200
Douglas County (state & private):	36,500
El Paso County (state & private):	47,900
Elbert County (state & private):	5,000

Total: 585,739

^{1/} Standard and special component areas on national forest land, all state and private lands.

TABLE V-2 - Colorado Springs
Raw Material Supply

Allowable Cut

Species	Size Class	bdft/cuft	allowable	bdft/cuft	product
Ponderosa pine	sawtimber	5 / 1	2,427 MCF	10/1	1,214 MCF
Ponderosa pine	poletimber	5 / 1	1,539	5/1	1,539
Spruce-fir	sawtimber	5 / 1	1,456	10/1	728
Spruce-fir	poletimber	5 / 1	923	5/1	923
Lodgepole	sawtimber	5 / 1	970	10/1	485
Lodgepole	sawtimber	5 / 1	615	5/1	615

Current Cut

Species	Size Class	bdft/cuft	current	bdft/cuft	product
Ponderosa pine	sawtimber	5 / 1	711 MCF	10/1	355 MCF
Ponderosa pine	poletimber	5 / 1	177	5/1	177
Spruce-fir	sawtimber	5 / 1	427	10/1	213
Spruce-fir	poletimber	5 / 1	106	5/1	106
Lodgepole	sawtimber	5 / 1	284	10/1	142
Lodgepole	poletimber	5 / 1	71	5/1	71

Recommended Cut

Species	Size Class	bdft/cuft	recommend	bdft/cuft	product
Ponderosa pine	sawtimber	5 / 1	7,157 MCF	10/1	3,578 MCF
Ponderosa pine	poletimber	5 / 1	588	5/1	588
Ponderosa pine (dead<5 yrs)		5 / 1	483	8/1	297
Ponderosa pine (salable dead>5 yrs)		5 / 1	490	5/1	490

Table V-3 - Colorado SpringsMaximum Mill Production Capacity 1/

<u>PRODUCT</u>	<u>OUTPUT CAPACITY</u>	<u>OUTPUT CAPACITY</u>
Pallets	15.6 MCF(of product)	31.2 MCF(of roundwood)
Dunnage	13.7	27.4
Timbers	2.0	4.0
Rough boards	422.3	844.6
Planed boards	15.7	31.4
Barn poles	18.8	18.8
Corral poles	3.7	3.7
Fence posts	15.5	15.5
Panelling	2.6	4.2
Dimension lumber	58.6	117.2
Firewood	489.6	796.2
Railroad ties	168.1	336.2
Wedges	2.0	2.0
Beams	10.5	21.0
Chips	383.9	
Sawdust	187.5	
Shavings	14.0	

1/ based on an 8 hr. day, 240 days/yr

TABLE V-4 - Colorado Springs

Current Annual Product Production

<u>PRODUCT</u>	<u>OUTPUT</u>	<u>OUTPUT</u>
Pallets	6.2 MCF (of product)	12.4 MCF (of roundwood)
Dunnage	5.5	11.0
Timbers	.8	1.6
Rough boards	110.7	221.4
Planed boards	15.7	31.4
Barn poles	18.8	18.8
Corral poles	3.7	3.7
Fence posts	15.5	15.5
Panelling	2.6	4.2
Dimension lumber	0.0	0.0
Firewood	122.4	199.0
Railroad ties	12.9	25.8
Wedges	.8	.8
Beams	10.5	21.0
Chips	94.9	
Sawdust	46.6	
Shavings	14.0	

TABLE V-5 - Colorado Springs

<u>Product Definition and Conversion Factors</u>			
Pallets	4'x4'	20 bdft/pallet	81.47 cuft/MBF
Dunnage	4'x4'	20 bdft/dunnage	81.47 cuft/MBF
Timbers	6"x6"x8'	not treated	81.47 cuft/MBF
Rough boards	1"x4"		81.47 cuft/MBF
Planed boards	1"x4"		54.67 cuft/MBF
Barn poles	6"x20'	3.92 cuft/pole	1 cuft/3 bdft-treated
Corral poles	3"x16'	.78 cuft/pole	1 cuft/3 bdft-treated
Fence posts	3.5"x6.5'	.43 cuft/post	1 cuft/3bdft-treated
Panelling	1"x4"	PP-blue stain	54.69 cuft/MBF
Dimension lumber	3"x6"		81.47 cuft/MBF
Firewood	4'x4'x8'	85 cuft/cord	
Railroad ties	6"x4"x6'	1 cuft/tie	
Wedges	1"x4"x6"	.02 cuft/wedge	
Beams	4"x4"x16'	1.76 cuft/beam	
Chips	43 cuft/MBF	25 lbs./cuft	
Sawdust	21 cuft/MBF		
Shavings	16 cuft/MBF		

TABLE V-6 - Colorado Springs

Alternative #1 Description

Constraints: -annual allowable cut on spruce-fir and lodgepole pine
 -recommended ponderosa pine cuts
 -annual cut on mortality ponderosa pine and salable dead
 -product capacity for each product

Goals: #1-minimize underachievement of recommended
 ponderosa pine cuts
 #2-maximization of returns to stumpage

Raw Material Supply(in MCF of roundwood)			Resources Used(in MCF of roundwood)
SF-Lp	sawtimber	2426.0	0.0
SF-Lp	poletimber	1538.0	0.0
PP	sawtimber	7157.0	1413.0
PP	poletimber	588.0	40.0
PP	dead <5yrs	483.0	483.0
PP	dead >5yrs	<u>490.0</u>	<u>195.2</u>
TOTAL		12,681.0.18	2131.2

Maximum Mill Production Capacity (MCF of roundwood)

pallets	31.2
dunnage	26.0
timbers	4.0
rough boards	844.6
planed boards	31.4
barn poles	18.8
corral poles	3.7
fence posts	15.5
panelling	4.2
dimension lumber	117.2
firewood	796.2
railroad ties	336.2
wedges	2.0
beams	21.0
chips	383.9
sawdust	187.5
shavings	14.0

SF - Lp = Spruce-fir, lodgepole pine

PP = ponderosa pine

TABLE V-7 - Colorado Springs

Alternative #2 Description

Constraints: -annual allowable cut on spruce-fir, lodgepole pine
 and ponderosa pine
 -recommended annual cuts on mortality and salable dead

Goals: #1-minimize underachievement of removing previous
 year ponderosa pine mortality
 #2-maximize returns to stumpage

Raw Material Supply(in MCF roundwood)			Resources Used(in MCF roundwood)
SF-Lp	sawtimber	2426.0	904.2
SF-Lp	poletimber	1538.0	0.0
PP	sawtimber	2428.0	0.0
PP	poletimber	1539.0	0.0
PP	dead<5yrs	483.0	483.0
PP	dead>5yrs	<u>490.0</u>	<u>489.6</u>
	TOTAL	8904.0	1876.8

Maximum Mill Production Capacity (MCF of roundwood)

pallets	31.2
dunnage	26.0
timbers	4.0
rough boards	844.6
planed boards	31.4
barn poles	18.8
corral poles	3.7
fence posts	15.5
panelling	4.2
dimension lumber	117.2
firewood	796.2
railroad ties	336.2
wedges	2.0
beams	21.0
chips	383.9
sawdust	187.5
shavings	14.0

TABLE V-8 - Colorado Springs

Alternative #3 Description

Constraints: -annual allowable cuts on spruce-fir, lodge-
 pole, and ponderosa pine
 -recommended annual cut on mortality
 ponderosa pine and salable dead

Goals: #1-maximization of returns to stumpage

Raw Material Supply (in MCF of roundwood)			Resources Used (in MCF of round- wood)
SF-Lp	sawtimber	2426.0	1392.0
SF-Lp	poletimber	1538.0	40.0
PP	sawtimber	2428.0	0.0
PP	poletimber	1539.0	0.0
PP	dead<5 yrs	483.0	483.0
PP	dead≥5 yrs	<u>490.0</u>	<u>205.7</u>
TOTAL		8904.0	2120.7

Maximum Mill Production Capacity (in MCF of roundwood)

pallets	31.2
dunnage	26.0
timbers	4.0
rough boards	844.6
planed boards	31.4
barn poles	18.8
corral poles	3.7
fence posts	15.5
panelling	4.2
dimension lumber	117.2
firewood	796.2
railroad ties	336.2
wedges	2.0
beams	21.0
chips	383.9
sawdust	187.5
shavings	14.0

TABLE V-9 - Colorado Springs

Alternative #4 Description

Constraints: -current cut level for lodgepole pine, spruce-fir
 and ponderosa pine
 -recommended annual cut for mortality pine
 -current annual production levels for each product

Goals: #1-maximization of returns to stumpage

Raw Material Supply(in MCF of roundwood)			Resources Used(in MCF of round- wood)
SF-Lp	sawtimber	710.0	303.6
SF-Lp	poletimber	177.0	38.8
PP	sawtimber	711.0	0.0
PP	poletimber	177.0	0.0
PP	dead<5 yrs	483.0	220.4
PP	dead>5 yrs	<u>490.0</u>	<u>0.0</u>
TOTAL		2747.0	562.8

Current Mill Production (MCF of roundwood)

pallets	12.4
dunnage	11.0
timbers	1.6
rough boards	221.4
planed boards	31.4
barn poles	18.8
corral poles	3.7
fence posts	15.5
panelling	4.0
dimension lumber	0.0
firewood	199.0
railroad ties	25.8
wedges	0.8
beams	21.0
chips	94.9
sawdust	46.6
shavings	14.0

TABLE V-10 - Colorado Springs

Raw Material Supply Versus Raw Material Consumed

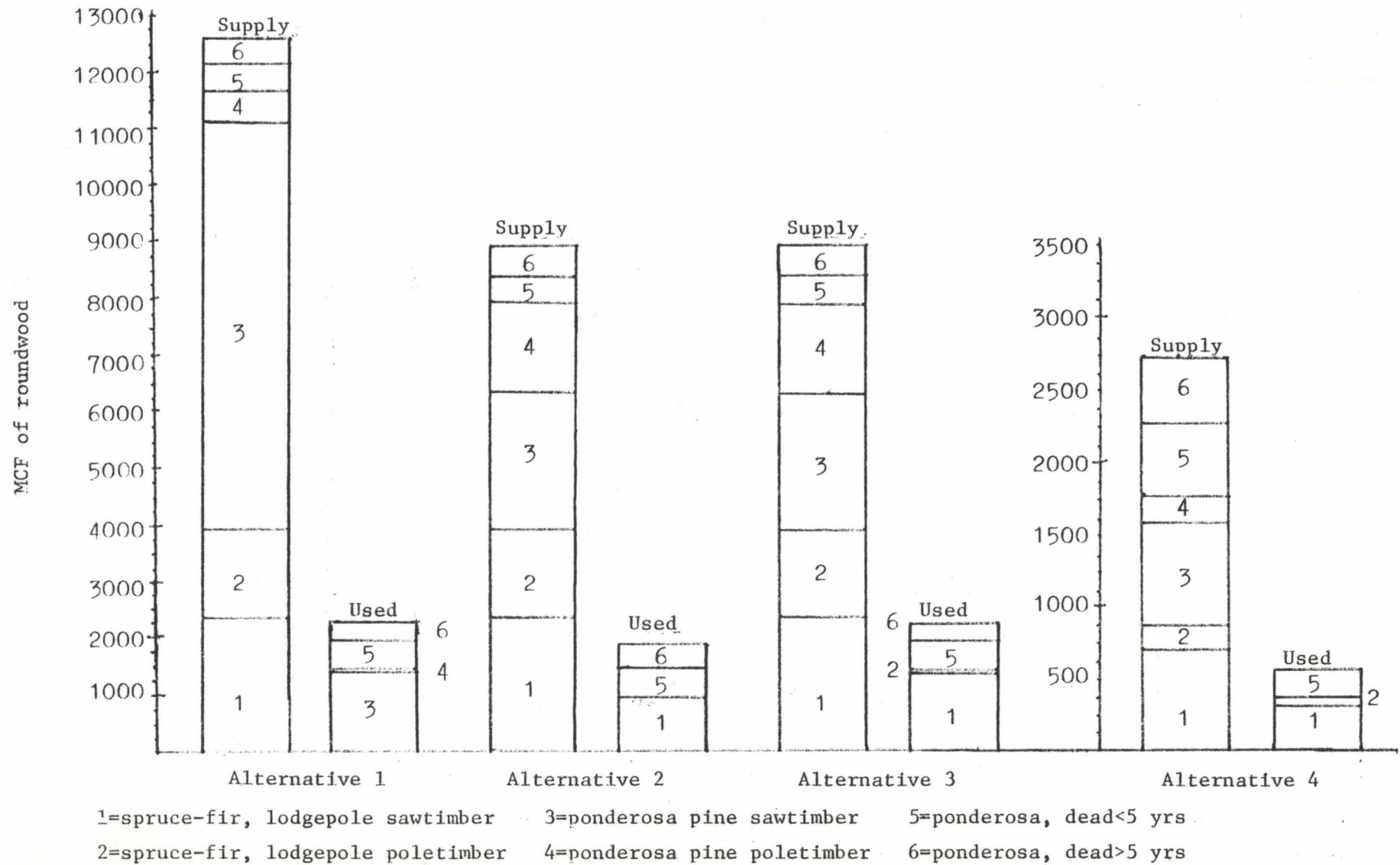


FIGURE V-3 - Market Area for Colorado Springs Processing Area

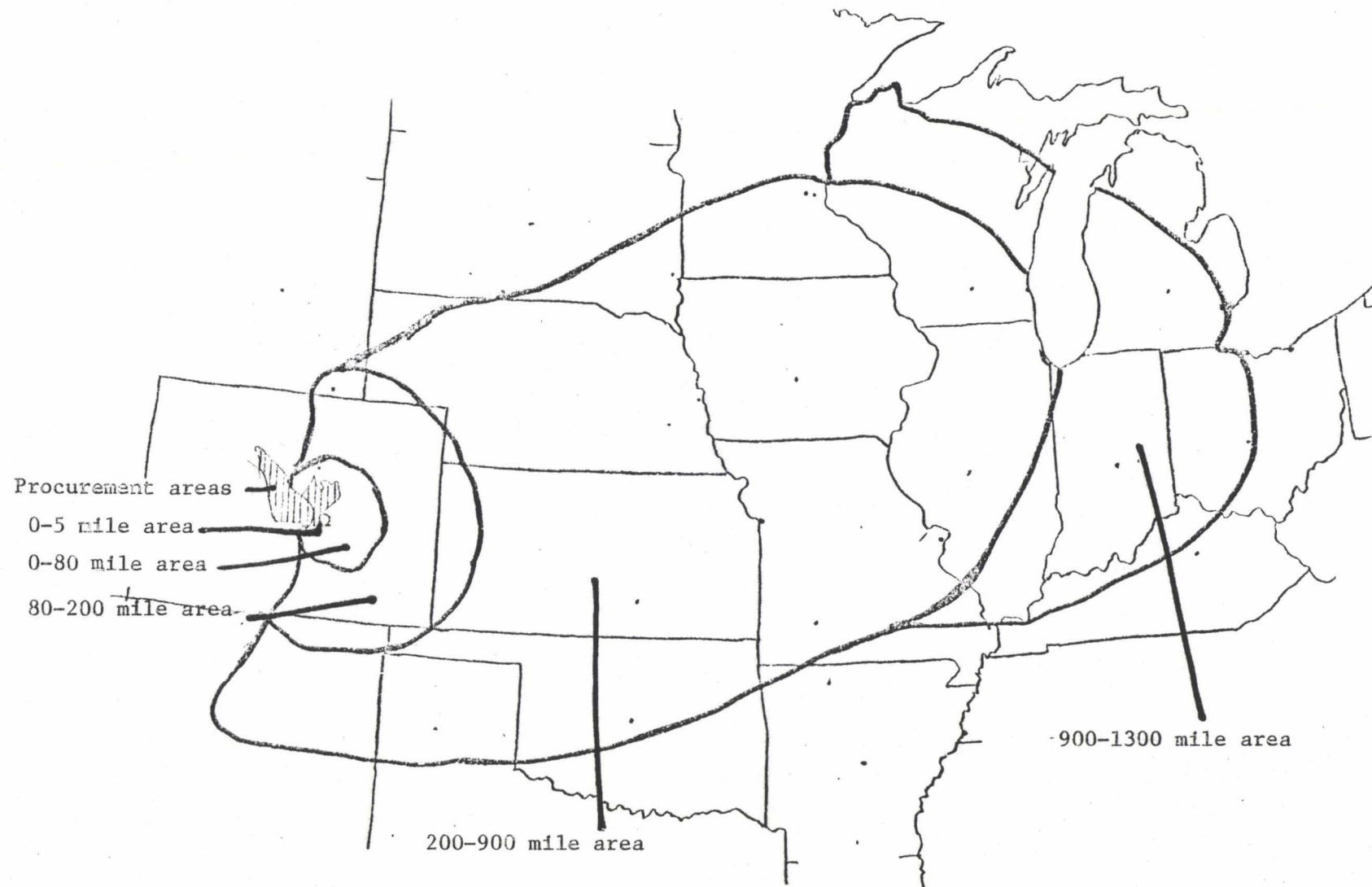


FIGURE V-4 - Transportation Isocost Map and Marketing Area for Colorado Springs

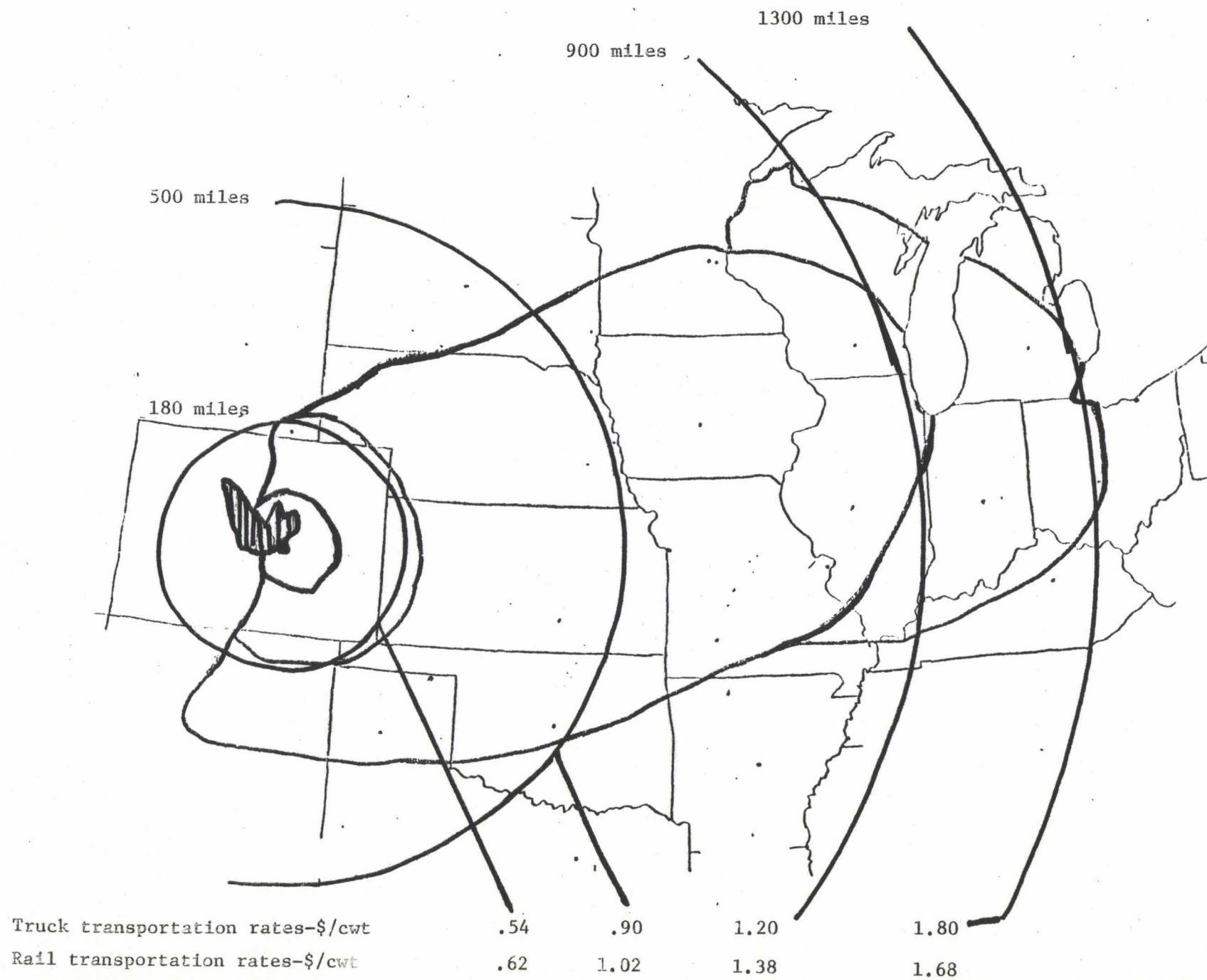


TABLE V-11 - Colorado Springs

MARKET CONSUMPTION: RESOURCES TO PRODUCTS (IN MCF)

Alt. 1		Alt. 2		Alt. 3		Alt. 4	
pallets (PP)	31.2	pallets (D<5)	25.4	pallets (SFLP)	31.2	pallets (SFLP)	12.4
timber (PP)	4.0	timbers (SFLP)	4.0	timbers (SFLP)	4.0	timbers (SFLP)	1.6
boards r (PP)	844.6	boards r (SFLP)	783.0	boards r (SFLP)	844.6	boards r (SFLP)	221.4
boards p (PP)	31.4	boards r (D<5)	50.1				
fence p (PP)	15.5			fence p (SFLP)	15.5	fence p (SFLP)	15.5
		boards p (D<5)	25.5				
				dimension (SFLP)	117.2		
dimension (PP)	117.2	fence p (D<5)	25.2			firewood (D<5)	199.0
firewood (D<5)	478.8			firewood (D<5)	372.3	beams (D<5)	17.1
		dimension (SFLP)	117.2	firewood (D>5)	205.7		
firewood (D<5)	195.2	firewood (D>5)	117.2			dunnage (SFLP)	11.0
				beams (D<5)	17.1	wedges (SFLP)	.8
beams (PP)	27.4	beams (D<5)	17.1				
				dunnage (SFLP)	27.4		
dunnage (PP)	2.0	dunnage (D<5)	22.3				
wedges (PP)	2.0	wedges (D<5)	22.3	wedges (SFLP)	2.0		

r = rough

p = planed; posts or poles

TABLE V-11 - Colorado Springs

MARKET ALLOCATIONS OF RESOURCES TO PRODUCTS (IN MCF)

	Alt. 1	Alt. 2	Alt. 3	Alt. 4
5-80 mile	barn p (PP) 18.8	barn p (D<5) 30.6	barn p (SFLP) 18.8	barn p (SFLP) 18.8
	corral p (PP) 3.7	corral p (D<5) 6.0	corral p (SFLP) 3.7	corral p (SFLP) 3.7
80-200 mile	railroad t (PP) 336.2	railroad t (D<5) 273.4	railroad t (SFLP) 336.2	railroad t (SFLP) 25.8
200- 900 mile	paneling (D<5) 4.2	paneling (D<5) 4.2	paneling (D<5) 4.2	paneling (D<5) 4.2
			boards p (SFLP) 31.4	boards p (SFLP) 31.4

t = ties

TABLE V-12 - Colorado Springs

Total Return Distribution By Market Zone and Alternative

		0-5 mile area	5-80 mile area	80-200 mile area	200-900 mile area
Alternative 1	Total revenue	\$107,249.2	\$ 9,137.2	\$ 27,736.6	\$ 5509.40
	Due to live PP	99,505.2	9,137.2	27,736.6	0.0
	Due to dead PP	7,744.0	0.0	0.0	5509.40
	Due to SF-LP	0.0	0.0	0.0	0.0
Alternative 2	Total revenue	\$122,360.2	\$ 8,359.3	\$ 23,197.80	\$ 5509.40
	Due to live PP	0.0	0.0	0.0	0.0
	Due to dead PP	56,219.9	8,359.3	23,297.80	5509.40
	Due to SF-LP	66,140.3	0.0	0.0	0.0
Alternative 3	Total revenue	\$127,544.9	\$ 10,046.4	\$ 35,469.1	\$ 19184.10
	Due to live PP	0.0	0.0	0.0	0.0
	Due to dead PP	17,865.7	0.0	0.0	5509.40
	Due to SF-LP	109,991.2	10,046.4	35,469.1	13674.70
Alternative 4	Total revenue	\$ 58,820.10	\$ 10,046.4	\$ 2721.90	\$ 19184.10
	Due to live PP	0.0	0.0	0.0	0.0
	Due to dead PP	12,828.90	0.0	0.0	5509.40
	Due to SF-LP	45,991.20	10,046.4	2721.90	13674.70

TABLE V-13 - Colorado Springs

RETURNS TO STUMPAGE

	Residual revenue due to live PP	Residual revenue due to live PP	Residual revenue due to SF-LP	Total residual revenue
Alternative 1	\$136,378.90	\$13,254.40	\$ 0.0	\$149,633.30
Alternative 2	\$ 0.0	\$93,286.40	\$ 66,140.30	\$159,426.70
Alternative 3	\$ 0.0	\$23,375.10	\$168,869.40	\$192,244.50
Alternative 4	\$ 0.0	\$18,338.30	\$ 72,434.20	\$ 90,772.50

Table V-14 - Colorado Springs

Mills Marginal Revenues, Marginal Costs,
Profit & Risk, and Residual

MR-MC-P&R=R*

MR(wholesale price)

MC(stumpage costs + procurement costs + milling costs + transportation to market costs)

P&R(10% of MC for profit & risk)

R(residual)

* (when R is less than 0 the product is considered uneconomical to market in the marketing area)

KEY

- 1) If there is no symbol in front of the product, it is currently marketed and is considered economical
- 2) * means the product is currently marketed and is considered uneconomical based on its R value
- 3) ** means the product is not currently marketed, but is considered economical to market.
- 4) *** means the product is not currently marketed, and is considered uneconomical.

(PP) Ponderosa Pine

(LP) Lodgepole Pine

(SF) Spruce-fir

(D<5) Ponderosa Pine-dead for five years or less.

Chips (D) = chips from dead wood

Chips (G) = chips from green wood

Table V-14 - Colorado Springs

0-5 mile Marketing Area

<u>PRODUCTS</u>	<u>MR/ (MCF)</u>	<u>MC/ (MCF)</u>	<u>P&R</u>	<u>RESIDUAL/ (MCF)</u>
Pallets(PP)	3000	2254	225	521
Pallets(LP)&(SF)	3000	2212	221	567
Pallets(D<5)	4000	2278	228	474
Dunnage(PP)	3000	2254	225	521
Dunnage(LP)&(SF)	3000	2212	221	567
Dunnage(D<5)	3000	2278	228	494
Timbers(PP)	1920	1653	165	102
Timbers(LP)&(SF)	1920	1611	161	148
Timbers(D<5)	1920	1677	169	76
Boards R(PP)	1800	1532	153	115
Boards R(LP)&(SF)	1800	1490	149	161
Boards R(D<5)	1800	1556	156	88
Boards P(PP)	1657	2928	293	436
BoardsP(LP)&(SF)	3840	2864	286	690
Boards P(D<5)	3474	2964	296	214
Barn P(PP)	3408	2758	276	374
Barn P(LP)&(SF)	3408	2716	272	420
Barn P(D<5)	1408	2794	279	335
CorralP(PP)	3012	2606	261	145
CorralP(LP)&(SF)	3012	2595	259	158
CorralP(D<5)	3012	2612	261	139
FenceP(PP)	4069	2476	248	1345
FenceP(LP)&(SF)	4069	2465	246	1358
Fence P(D<5)	4069	2482	248	1339
Panelling (D<5)	6399	4390	439	1570
Dimension L(PP)	2400	2180	218	2
Dimension L(LP)&(SF)	2400	2138	214	48
*Dimension L(D<5)	2400	2204	220	-24
Firewood(D<5)	529	462	46	21
Firewood (D<5)	529	474	47	8
RR Ties(PP)	1860	1593	159	108
RR Ties(LP)&(SF)	1860	1551	155	159
RR Ties(D<5)	1860	1640	164	56
Wedges(PP)	4000	3261	326	413
Wedges(SP)(SF)	4000	3219	322	459
Wedges(D<5)	4000	3297	330	373
Beams(PP)	4022	3065	306	651
Beams(LP)&(SF)	4022	3001	300	721
Beams(D<5)	4388	3101	310	977
*Chips(D)	37	42	4	-9
*Chips(G)	37	42	4	-9
*Shavings	37	42	4	-9
*Sawdust	37	42	4	-9

Table V-14 - Colorado Springs (cont)

5-80 Mile Marketing Area

<u>PRODUCTS</u>	<u>MR/(MCF)</u>	<u>MC/(MCF)</u>	<u>P&R</u>	<u>RESIDUAL/(MCF)</u>
Pallets(PP)	3000	2352	235	413
Pallets(LP)&(SF)	3000	2310	231	459
Pallets(D<5)	3000	2376	238	386
Dunnage(PP)	3000	2352	235	413
Dunnage(LP)&(SF)	3000	2310	231	459
Dunnage(D<5)	3000	2376	238	386
Timbers(PP)	1980	1746	175	59
Timbers(LP)&(SF)	1980	1704	170	106
Timbers(D<5)	1980	1770	177	33
***Boards R(PP)	1680	1584	158	-62
***Boards R(LP)&(SF)	1680	1542	154	-16
***Boards R(D<5)	1680	1608	161	-161
Boards P(PP)	3657	3007	300	350
Boards P(LP)&(SF)	3840	2943	294	603
Boards P(D<5)	3474	3043	304	127
Barn Poles(PP)	3564	2842	284	438
Barn Poles(LP)&(SF)	3564	2800	280	484
Barn Poles (D<5)	3564	2878	288	398
Corral P(PP)	3204	2691	269	244
Corral P(LP)&(SF)	3204	2680	268	256
Corral P(D<5)	3204	2697	270	237
Fence P(PP)	4069	2561	256	1252
Fence P(LP)&(SF)	4069	2550	255	1269
Fence P(D<5)	4069	2567	257	1245
Panelling(D<5)	6948	4449	445	2054
***Dimension L(PP)	2400	2232	223	-55
***Dimension L(LP)&(SF)	2400	2190	219	-9
***Dimension L(D<5)	2400	2256	226	-82
***Firewood(D<5)	768	819	82	-133
***Firewood(D<5)	768	831	83	-146
RR Ties(PP)	1920	1686	169	65
RR Ties(LP)&(SF)	1920	1644	164	112
RR Ties(D<5)	1920	1710	171	39
Wedges(PP)	4000	3355	335	310
Wedges(LP)&(SF)	4000	3313	331	356
Wedges(D<5)	4000	3391	339	270
Beams(PP)	4022	3144	314	564
Beams(LP)&(SF)	4022	3080	308	634
Beams(D<5)	4388	3180	318	890
*Chips	37	138	14	-115
*Shavings	37	138	14	-115
*Sawdust	37	138	14	-115

Table V-14 - Colorado Springs (cont)

80-200 Mile Marketing Area

<u>PRODUCTS</u>	<u>MR/ (MCF)</u>	<u>MC/ (MCF)</u>	<u>P&R</u>	<u>RESIDUAL/ (MCF)</u>
**Pallets(PP)	3000	2537	254	209
**Pallets(LP&SF)	3000	2495	249	256
**Pallets(D<5)	3000	2561	256	183
**Dunnage(PP)	3000	2517	254	209
**Dunnage(LP&SF)	3000	2495	249	249
**Dunnage(D<5)	3000	2561	256	256
**Timbers(PP)	2160	1874	187	99
**Timbers(LP&SF)	2160	1832	183	145
**Timbers(D<5)	2160	1898	190	72
Boards P(PP)	3657	3093	309	255
Boards P(LP&SF)	3840	3029	303	508
BoardsP (D<5)	2474	3129	313	32
Barn P(PP)	3360	3046	305	9
Barn P(LP&SF)	3360	3004	300	56
*Barn P(D<5)	3360	3082	308	-30
Fence P(PP)	3372	2768	277	327
Fence P(LP&SF)	3372	2757	276	339
Fence P(D<5)	3372	2774	277	321
Panelling(D<5)	5485	4551	455	479
**RR Ties (PP)	2160	1814	181	165
**RR Ties(LP&SF)	2160	1772	177	211
**RR Ties (D<5)	2160	1838	184	138
**Wedges (PP)	4000	3484	348	168
**Wedges(LP&SF)	4000	3442	244	214
**Wedges(D<5)	4000	3520	352	128
Beams(PP)	3657	3230	223	104
Beams(LP&SF)	3657	3166	317	174
Beams(D<5)	4022	3266	127	429
*Corral P(ALL)	-	-	-	-296
***Boards R(ALL)	-	-	-	-(very high)
***Dimension (ALL)	-	-	-	-(very high)
***Firewood (ALL)	-	-	-	-(very high)
***Chips (ALL)	-	-	-	-(very high)
***Shavings	-	-	-	-(very high)
***Sawdust	-	-	-	-(very high)

Table V-14 - Colorado Springs (cont)

200-900 Mile Marketing Area

<u>PRODUCTS</u>	<u>MR/ (MCF)</u>	<u>MC/ (MCF)</u>	<u>P&R</u>	<u>RESIDUAL/ (MCF)</u>
**BoardsP (PP)	3657	3261	326	70
**BoardsP (LP&SF)	4388	3197	320	871
***BoardsP (D<5)	3474	3297	330	-153
Fence P (PP)	4069	2602	360	107
Fence P (LP&SF)	4069	3591	359	119
Fence P (D<5)	4069	3608	461	100
**Panelling (D<5)	7314	4723	472	2119
**Beams (PP)	4022	3398	340	284
**Beams (LP&SF)	4022	3334	333	355
**Beams (D<5)	4388	3434	343	611
***Other Products	-	-	-	-(very high)

900-1300 Mile Marketing Area

***Boards P (PP)	3657	3473	347	-163
**BoardsP (LP&SF)	4388	3409	341	638
***Boards P (D<5)	3474	3509	351	-386
**Panelling (D<5)	7314	4935	494	1885
Beams (PP)	4022	3610	361	51
Beams (LP&SF)	4022	3546	355	121
Beams (D<5)	4388	3646	365	377
***Other Products	-	-	-	-(very high)
***Chips (D&G)	244	225	22	-3

Table V-15 - Cost Breakdown for Colorado Springs Processing Area

PRODUCTS (FC-L)	STUMPAGE ¹		PROCUREMENT		MILLING		P&R In Decimal	TRANSP MCF (0-5)	TRANSP MCF (5-80)	TRANSP MCF (80-200)
	MBF	MCF	MBF	MCF	MBF	MCF				
Pallets(PP)	3.00	36.00	64.51	774	119.99	1440	.10	4.0	102.45	286.88
Pallets(LP)	4.00	48.00	60.01	720	"	"	"	"	"	"
Pallets(SF)	"	"	"	"	"	"	"	"	"	"
Pallets(D<5)	.50	6.00	69.00	828	"	"	"	"	"	"
Dunnage(PP)	3.00	36.00	64.51	774	119.99	1440	.10	4.00	102.45	286.88
Dunnage(LP)	4.00	48.00	60.01	720	"	"	"	"	"	"
Dunnage(SF)	"	"	"	"	"	"	"	"	"	"
Dunnage(D<5)	.50	6.00	69.01	828	"	"	"	"	"	"
Timbers(PP)	3.00	36.00	64.51	774	70.00	840	.10	3.20	96.15	224.35
Timbers(LP)	4.00	48.00	60.01	720	"	"	"	"	"	"
Timbers(SF)	"	"	"	"	"	"	"	"	"	"
Timbers(D<5)	.50	6.00	69.01	828	"	"	"	"	"	"
Boards R(PP)	3.00	36.00	64.51	774	59.99	720	.10	1.80	54.00	-
Boards R(LP)	4.00	48.00	60.01	720	"	"	"	"	"	-
Boards R(SF)	"	"	"	"	"	"	"	"	"	-
Boards R (D<5)	.50	6.00	69.01	828	"	"	"	"	"	-
Boards P(PP)	3.00	54.85	64.51	1179	92.49	1691	.10	2.74	82.28	167.85
Boards P(LP)	4.00	73.14	60.01	1097	"	"	"	"	"	"
BoardsP(SF)	"	"	"	"	"	"	"	"	"	"
Boards P (D<5)	.50	9.14	69.01	1261	"	"	"	"	"	"
Barn poles (PP)	2.00	24.00	64.51	774	163.09	1957	.10	3.18	86.95	291.39
Barn Poles (LP)	3.00	36.00	60.01	720	"	"	"	"	"	"
Barn Poles (SF)	"	"	"	"	"	"	"	"	"	"
Barn Poles (D<5)	.50	6.00	69.01	828	"	"	"	"	"	"
Corralpoles (PP)	20..0	24.00	41.37	496	173.60	2083	.10	3.22	88.06	295.14
Corral poles (LP)	3.00	36.00	39.40	473	"	"	"	"	"	"

¹All figures are \$/MBF or \$/MCF

²PROD V - (Product value) refers to the marginal revenue from a product in a given market zone.

Table V-15 (cont)

PRODUCTS	TRANSP (200-900)	TRANSP ² (900-1300)	PROD V (0-5)		PROD V (5-80)		PROD V (80-200)		PROD V (200-900)		PROD V (900-1300)	
	MCF	MCF	MBF	MCF	MBF	MCF	MBF	MCF	MBF	MCF	MBF	MCF
Pallets(PP)	-	-	250	3000	250	3000	250	3000	250	3000	-	-
Pallets(LP)	-	-	"	"	"	"	"	"	"	"	-	-
Pallets(SF)	-	-	"	"	"	"	"	"	"	"	-	-
Pallets(D\5)	-	-	"	"	"	"	"	"	"	"	-	-
Dunnage(PP)	-	-	250	3000	250	3000	250	3000	250	3000	-	-
Dunnage(LP)	-	-	"	"	"	"	"	"	"	"	-	-
Dunnage(SF)	-	-	"	"	"	"	"	"	"	"	-	-
Dunnage(D\5)	-	-	"	"	"	"	"	"	"	"	-	-
Timbers(PP)	-	-	160	1920	165	1980	180	2160	-	-	-	-
Timbers(LP)	-	-	"	"	"	"	"	"	-	-	-	-
Timbers(SF)	-	-	"	"	"	"	"	"	-	-	-	-
Timbers(D\5)	-	-	"	"	"	"	"	"	-	-	-	-
BoardsR(PP)	-	-	150	1800	140	1680	150	1800	-	-	-	-
BoardsR(LP)	-	-	"	"	"	"	"	"	-	-	-	-
BoardsR(SF)	-	-	"	"	"	"	"	"	-	-	-	-
BoardsR(D5)	-	-	"	"	"	"	"	"	-	-	-	-
BoardsP(PP)	336	548	200	2657	200	3657	200	3657	200	3657	-	-
BoardsP(LP)	"	"	210	3840	210	3840	210	3840	240	4388	240	4388
BoardsP(SF)	"	"	"	"	"	"	"	"	"	"	-	-
BoardsP(D\5)	"	"	190	3474	190	3474	190	3474	190	3474	-	-
BarnPoles(PP)	-	-	284	3408	297	3564	280	3360	-	-	-	-
BarnPoles(LP)	-	-	"	"	"	"	"	"	-	-	-	-
BarnPoles(SF)	-	-	"	"	"	"	"	"	-	-	-	-
BarnPoles(D\5)	-	-	"	"	"	"	"	"	-	-	-	-
CorralPoles(PP)	-	-	251	3012	267	3204	240	2880	-	-	-	-
CorralPoles(LP)	-	-	"	"	"	"	"	"	-	-	-	-
CorralPoles(SF)	-	-	"	"	"	"	"	"	-	-	-	-
CorralPoles (D\5)	-	-	"	"	"	"	"	"	-	-	-	-
FencePosts(PP)	1129	-	339	4069	339	4069	281	3372	339	4069	-	-
FencePosts(LP)	"	-	"	"	"	"	"	"	"	"	-	-
FencePosts(SF)	"	-	"	"	"	"	"	"	"	"	-	-
FencePosts (d\5)	"	-	"	"	"	"	"	"	"	"	-	-

Table V-15 (cont)

PRODUCTS (FC-L)	STUMPAGE <i>per</i> MBF MCF		PROCUREMENT MBF MCF		MILLING MBF MCF		P&R %	TRANSP MCF (0-5)	TRANSP MCF (5-80)	TRANSP MCF (80-200)
Corralpoles "	"	"	"	"	"	"	"	"	"	"
(SF)										
Corral poles.50	6.00		43.34	520	"	"	"	"	"	"
(D\5)										
Fence posts 2.00	24.00		41.37	496	162.73	1953	.10	3.22	88.06	295.14
(PP)										
Fence posts 3.00	36.00		39.40	473	"	"	"	"	"	"
(LP)										
Fence posts "	"	"	"	"	"	"	"	"	"	"
(SF)										
Fence posts .50	6.00		43.34	520	"	"	"	"	"	"
(d\5)										
Panelling .50	9.14		69.01	1261	170.49	3117	.10	2.74	61.65	164.40
DimensionL 30..0	36.00		64.51	774	114	1368	.10	1.80	54.00	160.0
(PP)										
Dimension L 4.00	48.00		60.01	720	"	"	"	"	"	"
(LP)										
Dimension L "	"	"	"	"	"	"	"	"	"	"
(SF)										
Dimension L .50	6.00		69.01	828	"	"	"	"	"	"
(D\5)										
Firewood(D\5).50	6.00		36.50	438	0	0	.10	17.60	374.95	-
Firewood(D\5)"	"		37.50	450	"	"	"	"	"	-
RR Ties(PP) 3.00	36.00		64.51	774	65.00	780	.10	3.20	96.15	224.05
RR Ties(LP) 4.00	48.00		60.01	720	"	"	"	"	"	"
RR Ties(SF) "	"	"	"	"	"	"	"	"	"	"
RR Ties .50	6.00		69.01	828	"	"	"	"	"	"
(D\5)										
Wedges(PP) 2.00	24.00		64.51	774	205.0	2460	.10	3.22	96.77	226.8
Wedges(LP) 3.00	36.00		60.01	720	"	"	"	"	"	"
Wedges(SF) "	"	"	"	"	"	"	"	"	"	"
Wedges(D\5) .50	6.00		69.01	828	"	"	"	"	"	"
Beams(PP) 3.00	54.85		68.51	1179	100.0	1828	.10	274	82.28	167.85
Beams(LP) 4.00	73.14		60.01	1097	"	"	"	"	"	"
Beams(SF) "	"	"	"	"	"	"	"	"	"	"
Beams(D\5) .50	9.14		69.01	1261	"	"	"	"	"	"
Chips(D) -	-	-	-	-	3.00	36.00	.10	5.81	101.74	349.00
Chips(G) -	-	-	-	-	"	"	"	"	"	"
Shavings -	-	-	-	-	3.00	36.00	.10	5.81	101.74	349.00
Sawdust -	-	-	-	-	3.00	36.00	.10	5.81	101.74	349.00

Table V-15 (cont)

PRODUCTS	TRANSP (200-900)	TRANSP (900-1300)	PROD V (0-5)		PROD V (5-80)		PROD V (80-200)		PROD V (200-900)		PROD V (900-1300)	
	MCF	MCF	MBF	MCF	MBF	MCF	MBF	MCF	MBF	MCF	MBF	MCF
Panelling (D<5)	336	548	350	6399	380	7998	300	5488	400	7314	400	7314
Dimension L (PP)	-	-	200	2400	200	2400	210	2520	-	-	-	-
Dimension (LP)	-	-	"	"	"	"	"	"	-	-	-	-
Dimension L (SF)	-	-	"	"	"	"	"	"	-	-	-	-
Dimension L (D<5)	-	-	"	"	"	"	"	"	-	-	-	-
Firewood (D<5)	-	-	44	529	64	768	49	588	-	-	-	-
Firewood (D>5)	-	-	"	"	"	"	"	"	-	-	-	-
RR Ties (PP)	-	-	155	1860	160	1920	180	2160	-	-	-	-
RR Ties (LP)	-	-	"	"	"	"	"	"	-	-	-	-
RR Ties (SF)	-	-	"	"	"	"	"	"	-	-	-	-
RR Ties (D<5)	-	-	"	"	"	"	"	"	-	-	-	-
Wedges (PP)	-	-	333	4000	333	4000	333	4000	-	-	-	-
Wedges (LP)	-	-	"	"	"	"	"	"	-	-	-	-
Wedges (SF)	-	-	"	"	"	"	"	"	-	-	-	-
Wedges (D<5)	-	-	"	"	"	"	"	"	-	-	-	-
Beams (PP)	336	548	220	4022	220	4022	200	3657	220	4022	220	4022
Beams (LP)	"	"	220	4022	220	4022	200	4657	220	4022	220	4022
Beams (SF)	"	"	220	4022	220	4022	200	3657	220	4021	220	4022
Beams (D<5)	"	"	240	4388	240	4388	220	4022	240	4388	240	4388
Chips (D)	-	181.47	-	37	-	37	-	187	-	-	-	244
Chips (G)	-	"	-	37	-	37	-	187	-	-	-	244
Shavings	-	-	-	37	-	37	-	187	-	-	-	-
Sawdust	-	-	-	37	-	37	-	187	-	-	-	-

CASE STUDY V - Colorado Springs Tributary Area

Summary AnalysisRaw Material Supply Versus Amount Consumed

Each of the alternatives for this case study resulted in an excess of raw material supply over raw material consumed.

Supply-Consumption Differential

<u>Alternative</u>	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>
	10,549.8	7,027.2	6,783.3	2,184.2 MCF

The high quantity of unused material in Alternative 1 results from a large recommended ponderosa pine cut as called for in the constraints. (See Table V-6) Alternatives 2 and 3, based on allowable cut for ponderosa pine sawtimber, yield about one-third of the recommended cut quantity. Considerable amounts of raw material are left unused in each alternative due to mill production limits. An increase, for example, in production levels, expansion of mills, or production rate would result in more complete utilization of the potential supply levels. An increase in current production rates would have the same effect on current raw material supplies (see Table V-9), resulting in increased output.

Utilization of All Ponderosa Pine Types

The raw material supply depicted in Tables V-6, 7, 8, and 9 show the supply of ponderosa pine types under different cutting schedules; allowable cut, current cut, or recommended cut. The following table lists the totals for each alternative:

<u>Alternative</u>	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>
Ponderosa pine supply (MCF)	8717.0	4940.0	4940.0	1860.0
Ponderosa pine used (MCF)	2131.2	972.6	688.7	220.4

The highest percentage of Ponderosa pine used is in Alternative 1 due to the priority goal of using Ponderosa pine sawtimber and poletimber. The

component of this total supply in beetle-killed wood dead <5 years was totally used in the first three alternatives and nearly 50% consumed in the fourth. This wood was consumed, in general, as firewood, boards, beams, barn poles, in accordance with its priority goal. Alternative 3 uses the least ponderosa pine since maximization of returns forces use of the higher return spruce-fir, lodgepole pine products.

Utilization of Beetle-killed Ponderosa Pine

The table below summarizes the quantities of beetle-killed pine supplied and used in each alternative.

<u>Alternative</u>	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	
Beetle-killed supply	973.0	973.0	973.0	973.0	MCF
Beetle-killed used	678.2	972.6	688.7	220.4	

All the alternatives used a high percentage of beetle-killed pine except #4, due to lower mill production limits. Spruce-fir and lodgepole pine comprised the largest component of consumption, with beetle-killed pine second, due to its higher return on products than live ponderosa pine which was left untouched.

Overall Returns to Stumpage

Alternative 1 yielded the greatest proportion of returns from ponderosa pine sawtimber, poletimber, and beetle-killed wood combined, 100%, of all the alternatives. The supply of ponderosa pine material was adequate to allow all possible products to be produced.

Raw Material Types as a Percentage of Supply, Consumption and Revenue

<u>Alternative</u>	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>
Ponderosa pine as % total supply used	68.7 100	55.5 51.8	55.5 32.5	67.7 39.2
Revenue as a % of total	100	58.5	12.2	20.2
Spruce-fir, Lodgepole as % of total supply used	31.3 0.0	44.5 48.2	44.5 67.5	32.3 60.8
Revenue as a % of total	0.0	41.5	87.8	79.8
Total revenue	\$149,633	159,426	192,244	90,772

Alternative 3 yields the highest overall revenue due to its single goal of maximizing returns. The ponderosa pine used in this alternative was beetle-killed wood dead <5 years for firewood, paneling, beams, and dead >5 years for firewood.

Alternative 2 realizes the greatest consumption level of ponderosa pine at 52% of the total. The goal, maximum use of previous year mortality, resulted in the use of beetle-killed wood for fairly high return products making up 59% of total revenue. As the production capacity of some product lines was exhausted, spruce-fir, lodgepole pine was consumed in the form of lesser return/MCF products resulting in the lower ratio of used SFLP to percentage of total revenue not seen in the other alternatives.

In Alternative 4, the raw material supply is sufficiently low as to leave one product line with additional capacity. While the total supply is consumed, beams, a high residual value product, has remaining production potential.

Market Consumption of Products

Tables V-11, 12, and 13 are all concerned with the consumption of products produced and the rate of residual each product returns. Table V-11 shows that the majority of product lines produced in the Colorado Springs center are consumed within five miles. As would be expected, Table V-12 which shows the distribution of returns, reveals the highest returns in the 0-5 mile area for every material type in all of the alternatives. This table also displays those products with a return sufficient enough to support their marketing in more distant zones, 80-200 and 200-900 miles. These are ponderosa pine beetle-killed products and spruce-fir, lodgepole pine products. Table V-13, returns to stumpage, shows sums of residual returns by raw material type.

Analysis

As in the original goal program run, the supply of raw material available in each alternative exceeded the amount actually consumed. In the sensitivity analysis the amount of material consumed was less than that level consumed in the original analysis. (See Table I-16)

Resources Used (MCF of roundwood)

Alternative	1	2	3	4	
Original Analysis	4863	4722	4713	2228	MCF
Sensitivity Analysis	3630	3813	3630	1925	MCF

This drop in the level of raw material used, or consumed, is due to the local market restriction. Each product was analyzed in terms of marginal revenue, marginal costs, profit and risk factors to determine the residual return from the product in the individual marketing zones. (See Table I-14) As a result of this analysis some products were found to be uneconomical to market in certain zones due to a negative residual. If this were the case, the product, through the goal program, was not made available for marketing, or consumption, in the uneconomical zone. In the Colorado Springs case study, this outcome resulted in some products being restricted to sales only in the 0-5 mile marketing zone. With the imposition of a constrained consumption level in the 0-5 mile market zone, many products were produced up to that level and not beyond.

General Consumption Breakdown

The typical consumption patterns of product lines are summarized in the table below. This table represents general consumption of products in the program with no demand constraints.

0 - 5 Mile	pallets	5 - 80 barn poles
	timbers	borral poles
	boards	
	fence posts	80 - 200 railroad ties
	dimension lumber	
	firewood	200 - 900 paneling
	beams	boards planed
	dunnage	
	wedges	

Optimum Ponderosa Pine Utilization

The highest potential for utilization of ponderosa pine is found in alternative 1, which by its goals encourages its use over other raw materials. This alternative yields the highest returns due to live ponderosa pine material. Alternative 2, emphasizing removal of mortality pine maximizes residual revenue from dead or beetle-killed ponderosa pine. Products which maximize returns from live ponderosa pine in alternative 1 and dead ponderosa pine in alternative 2 are listed:

Products from Live Ponderosa Pine

pallets
timber
boards
fence posts
dimension lumber
beams
dunnage
wedges
barn poles
corral poles
railroad ties

Products from Dead Ponderosa Pine

pallets
boards
fence posts
firewood
beams
dunnage
wedges
barn poles
corral poles
railroad ties
paneling

Product Profit Potentials

The study of revenue and cost figures in Table V-15 has shown, in many

cases, profit potentials for products not currently marketed in certain zones.

to. These products are summarized below by zone:

80-200 Mile Zone:

<u>Products</u>	<u>Returns to stumpage (\$/MCF of roundwood)</u>
pallets - PP	54.50
pallets - SFLP	128.00
pallets - D<5	91.50
dunnage - PP	54.50
dunnage - SFLP	124.50
dunnage - D<5	128.00
timbers - PP	49.50
timbers - SFLP	72.50
timbers - D<5	36.00
railroad ties - PP	82.50
railroad ties - SFLP	105.50
railroad ties - D<5	69.00
wedges - PP	84.00
wedges - SFLP	107.00
wedges - D<5	114.00

200-900 Mile Zone:

<u>Products</u>	<u>Returns to stumpage (\$/MCF of roundwood)</u>
boards, planed - PP	35.00
boards, planed - SFLP	435.00
paneling - D<5	1059.05
beams - PP	142.00
beams - SFLP	177.5
beams - D<5	305.50

900-1300 Mile Zone:

<u>Products</u>	<u>Returns to stumpage (\$/MCF of roundwood)</u>
boards, planed - SLFP	319.00
paneling - D<5	942.50

Several products are currently marketed but in this study were found to be presently marketed at a loss per MCF. They are listed below by marketing zones. (See Table V-14)

Products Presently Marketed with an Uneconomical Residual0-5 Mile Zone:

<u>Product</u>	<u>Return to stumpage (\$/MCF of roundwood)</u>
dimension lumber - D<5	-12.00
chips	- 9.00
shavings	- 9.00
sawdust	- 9.00

5-80 Mile Zone:

<u>Product</u>	<u>Return to stumpage (\$/MCF of roundwood)</u>
chips	-115.00
shavings	-115.00
sawdust	-115.00

80-200 Mile Zone:

<u>Product</u>	<u>Return to stumpage (\$/MCF of roundwood)</u>
barn poles - D<5	- 30.00
corral poles (all)	-296.00

SFLP = spruce-fir, lodgepole
D<5 = Ponderosa pine, dead<5 years

PP = Ponderosa Pine

Colorado Springs Tributary Area

Sensitivity Analysis

The supply of raw material exceeded the consumption for each alternative in this sensitivity test, as was also the case in the original goal program run. The levels of resources used for the original and the sensitivity runs are presented in the following table. (Also see Table V-16)

Resources Used (MCF of roundwood)

<u>Alternative</u>	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>
Original Analysis	2131.2	1876.8	2120.7	562.8
Sensitivity Analysis	671.2	570.5	667.2	184.3

Such a large drop in resource utilization reflects the effect of the demand limitation on consumption in the 0-5 mile market zone. In this zone, firewood was originally consumed at a level of 489 MCF. For the sensitivity analysis, the level was reduced to 10%, or 49 MCF. Due to the marginal analysis constraint, firewood is uneconomical in other market zones. This resulted in a reduction of 420 MCF of firewood that could have been produced.

Rough boards and dimension lumber were other products found to be economical only in the 0-5 zone, resulting in further "loss of sales" and less raw materials used.

The following table summarizes, by raw material type, the differences in consumption levels between original and sensitivity analyses for the Colorado Springs tributary area:

Raw Material Used: Original Alternative minus Sensitivity

	<u>Alt 1-Alt 1-s</u>	<u>Alt 2-Alt 2-s</u>	<u>Alt 3-Alt 3-s</u>	<u>Alt 4-Alt 4-s</u>
SFLP sawtimber	0.0	865.6	865.6	199.2
SFLP poletimber	0.0	0.0	0.0	0.0
PP sawtimber	865.6	0.0	0.0	0.0
PP poletimber	0.0	0.0	0.0	0.0
PP dead <5 yrs.	399.2	0.0	382.2	179.3
PP dead >5 yrs.	195.2	440.7	205.7	0.0

TABLE V-16 - Colorado Springs: SENSITIVITY STUDY

Raw Material Supplies Versus Raw Material UsedAlternative 1

<u>Supply (MCF of roundwood):</u>			<u>Resources Used (MCF of roundwood):</u>	
SFLP	sawtimber	2,426.0	0.0	
SFLP	poletimber	1,538.0	0.0	
PP	sawtimber	7,156.0	547.4	
PP	poletimber	588.0	40.0	
PP	dead <5 yrs.	483.0	83.8	
PP	dead >5 yrs.	490.0	0.0	
TOTAL:		12,681.0	671.2	MCF

Alternative 2

<u>Supply (MCF of roundwood):</u>			<u>Resources Used (MCF of roundwood):</u>	
SFLP	sawtimber	2,426.0	38.6	
SFLP	poletimber	1,538.0	0.0	
PP	sawtimber	2,428.0	0.0	
PP	poletimber	1,539.0	0.0	
PP	dead <5 yrs.	483.0	483.0	
PP	dead >5 yrs.	490.0	48.9	
TOTAL:		8,904.0	570.5	MCF

Alternative 3

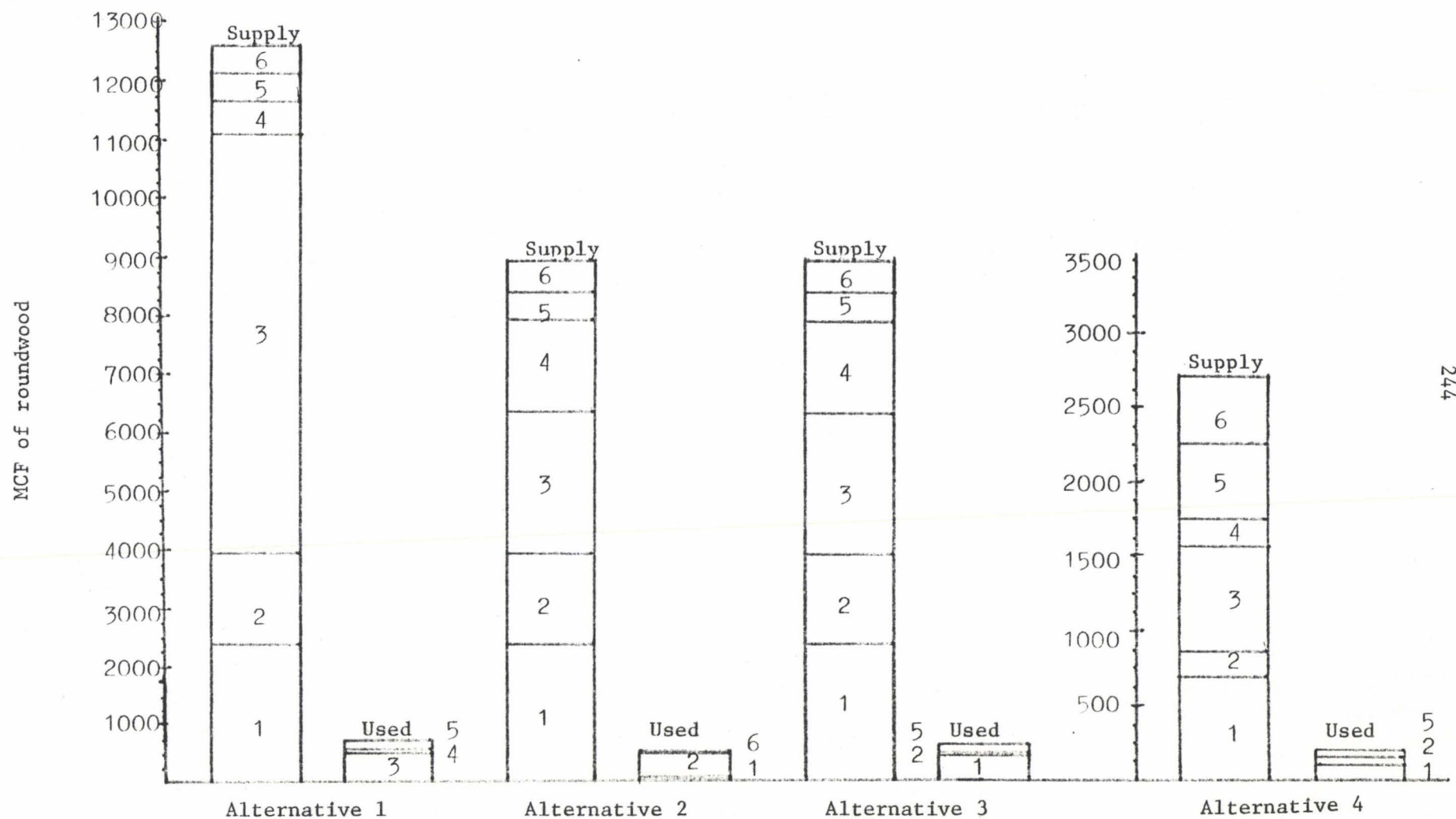
<u>Supply (MCF of roundwood):</u>			<u>Resources Used (MCF of roundwood):</u>	
SFLP	sawtimber	2,426.0	526.4	
SFLP	poletimber	1,538.0	40.0	
PP	sawtimber	2,428.0	0.0	
PP	poletimber	1,539.0	0.0	
PP	dead <5 yrs.	483.0	100.8	
PP	dead >5 yrs.	490.0	0.0	
TOTAL:		8,904.0	667.2	MCF

Alternative 4

<u>Supply (MCF of roundwood):</u>			<u>Resources Used (MCF of roundwood):</u>	
SFLP	sawtimber	710.0	104.4	
SFLP	poletimber	177.0	38.8	
PP	sawtimber	710.0	0.0	
PP	poletimber	177.0	0.0	
PP	dead <5 yrs.	483.0	41.1	
PP	dead >5 yrs.	490.0	0.0	
TOTAL:		2,747.0	184.3	MCF

TABLE V-17 - Colorado Springs: SENSITIVITY STUDY

Raw Material Supply versus Raw Material Consumed



1=Spruce-fir, lodgepole sawtimber
2=Spruce-fir, lodgepole poletimber

3=Ponderosa pine sawtimber
4=Ponderosa pine poletimber

5=Ponderosa, dead 5<yrs.
6=Ponderosa, dead 5>yrs.

Based on a lower level of product consumption and a shifting of product allocation to less economical zones, returns to stumpage for each sensitivity alternative are less than those for the original alternatives.

Difference in Returns to Stumpage: Original Analysis minus Sensitivity

	0-5 miles	5-80 miles	80-200 miles	200-900 miles	Total Diff.
Alt 1-Alt 1-s	\$ 96,126	-39,059	-178	0.0	\$56,889
Alt 2-Alt 2-s	\$111,994	-38,100	-129	0.0	\$73,765
Alt 3-Alt 3-s	\$114,371	-38,648	-261	0.0	\$75,462
Alt 4-Alt 4-s	\$ 52,849	-31,040	-116	0.0	\$21,693

Restrained by the demand limitation in the 0-5 zone, consumption of most products occurs in other economical market zones. In this case, the products originally consumed in the 0-5 zone, now appear in the 5-80 zone. This results in greater returns in that zone as compared to the original analysis and less returns in the closest zone. However, overall returns show a definite loss in the sensitivity analyses. (See Tables V-18 and 19.)

The demand limitation in 0-5 mile market zone resulted in a change in the consumption pattern and levels of total consumption, as shown in Table V-20. The shifts suggested above may be observed by comparing ties with Table V-11. As a general indication of the sensitivity analysis pattern, the following table is presented:

General Product Consumption Breakdown

<u>Original Alternatives/Sensitivity</u>		
0-5 Mile zone	pallets timbers boards, rough fence posts dimension lumber firewood beams dunnage wedges	pallets timbers boards, rough fence posts dimension lumber firewood beams dunnage wedges
5-80 Mile zone	barn poles corral poles	pallets barn poles corral poles fence posts beams dunnage wedges

<u>Original Alternatives/Sensitivity</u>		
80-200 Mile zone	railroad ties	timbers railroad ties
200-900 Mile zone	paneling boards, planed	paneling boards, planed

TABLE V-18 - Colorado Springs: SENSITIVITY STUDY
Total Return Distribution Per Market Zone and Alternative

	0-5 Mile Zone	5-80 Mile Zone	80-200 Mile Zone	200-900 Mile Zone
<u>Alternative 1</u>				
Total returns	\$11,123.40	\$48,196.50	\$27,914.70	\$5,509.40
Due to PP Live	10,096.50	48,196.50	27,914.70	0.00
Due to PP Dead	1,026.90	0.00	0.00	5,509.40
Due to SFLP	0.00	0.00	0.00	0.00
<u>Alternative 2</u>				
Total returns	\$10,365.90	\$46,459.30	\$23,327.40	\$5,509.40
Due to PP live	0.00	0.00	0.00	0.00
Due to PP Dead	8,217.70	46,459.30	23,197.80	5,509.40
Due to SFLP	2,148.20	000.00	129.60	000.00
<u>Alternative 3</u>				
Total returns	\$13,174.20	\$48,694.50	\$35,730.10	\$19,184.10
Due to PP live	0.00	0.00	0.00	0.00
Due to PP Dead	2,101.60	8,366.00	000.00	5,509.40
Due to SFLP	11,072.60	40,328.50	35,730.10	13,674.70
<u>Alternative 4</u>				
Total returns	\$ 5,971.10	\$41,086.30	\$ 2,837.90	\$19,184.10
Due to PP Live	0.00	0.00	0.00	0.00
Due to PP Dead	1,330.30	8,366.00	0.00	5,509.40
Due to SFLP	4,640.80	32,720.30	2,837.90	13,674.70

TABLE V-19 - Colorado Springs: SENSITIVITY STUDY

RETURNS TO STUMPAGE

	Revenue due to Ponderosa Pine	Revenue due to dead Ponderosa Pine	Revenue due to Spruce-fir-lodgepole	Total Revenues
<u>Alternative 1</u>	\$86,207.70	\$ 6,536.30	000.00	\$ 92,744.00
Alternative 2	000.00	83,384.20	2,277.80	\$ 85,662.00
Alternative 3	000.00	15,977.00	100,805.90	\$116,732.90
Alternative 4	000.00	15,205.70	53,873.70	\$ 69,079.40

TABLE V-20 - Colorado Springs: SENSITIVITY STUDY

Market Consumption: Resources to Products (MCF of Roundwood)

		Alternative 1		Alternative 2		Alternative 3		Alternative 4	
0-5 Mile Zone	Pallets (PP)	3.2	Pallets (D<5)	2.6	Pallets (SFLP)	3.2	Pallets (SFLP)	1.2	
	Timbers (PP)	0.4	Timbers (SFLP)	0.4	Timbers (SLFP)	0.4			
	Boards R(PP)	84.4	Boards R(D<5)	50.0					
			Boards R(SFLP)	22.8	Boards R(SFLP)	84.4	Boards R(SFLP)	22.2	
	Boards P (PP)	3.2	Boards P(D<5)	2.6					
	Fence P (PP)	1.6	Fence P (D<5)	2.6	Fence P(SFLP)	1.6	Fence P(SFLP)	1.6	
	Dimension (PP)	11.8	Dimension(SFLP)	11.8	Dimension(SFLP)	11.8			
	Firewood (D<5)	79.5	Firewood (D<5)	48.9	Firewood (D<5)	79.5	Firewood (D<5)	19.8	
	Beams (PP)	2.2	Beams (D<5)	1.8	Beams (D<5)	1.8	Beams (D<5)	1.8	
	Dunnage (PP)	2.8	Dunnage (D<5)	2.3	Dunnage (SFLP)	2.8	Dunnage (SFLP)	1.2	
5-80 Mile Zone	Wedges (PP)	0.2	Wedges (D<5)	0.3	Wedges (SFLP)	0.2			
	Pallets (PP)	28.0	Pallets (D<5)	22.8	Pallets (SFLP)	28.0	Pallets (SFLP)	11.2	
	Boards P (PP)	28.2	Boards P(D<5)	22.9					
	Barn P (PP)	18.8	Barn P (D<5)	30.6	Barn P (SFLP)	18.8	Barn P (SFLP)	18.8	
	Corral P (PP)	3.7	Corral P (D<5)	6.0	Corral P (SFLP)	3.7	Corral P (SFLP)	3.7	
	Fence P (PP)	13.9	Fence P (D<5)	22.6	Fence P (SFLP)	13.9	Fence P (SFLP)	13.9	
	Beams (PP)	18.8	Beams (D<5)	15.3	Beams (D<5)	15.3	Beams (D<5)	15.3	
	Dunnage (PP)	24.6	Dunnage (D<5)	20.0	Dunnage (SFLP)	24.6	Dunnage (SFLP)	9.8	
	Wedges (PP)	1.8	Wedges (D<5)	2.9	Wedges (SFLP)	1.8	Wedges (SFLP)	0.8	
80-200 Mile Zone	Timbers (PP)	3.6	Timbers (SFLP)	3.6	Timbers (SFLP)	3.6	Timbers (SFLP)	1.6	
	RR Ties (PP)	336.2	RR Ties (D<5)	273.4	RR Ties (SFLP)	336.2	RR Ties (SFLP)	25.8	
200-900 Mile Zone	Paneling (D<5)	4.2	Paneling(D<5)	4.2	Paneling (D<5)	4.2	Paneling(D<5)	4.2	
					Boards P(SFLP)	31.4	Boards P(SFLP)	31.4	

Canon City-Florence-Penrose Case Study

CASE STUDY VI:

The Canon City-Florence-Penrose Case Study has a timber procurement base of over 1,030,000 acres. This procurement acreage was developed in CSU Report #2192. As detailed earlier in this report, the procurement zone encompasses areas of present or potential supply for area mills. To avoid the complexity of overlapping procurement areas between processing centers, the center holding a competitive advantage was considered to be the sole timber buying center. The Canon City-Florence-Penrose procurement area encompasses state and private lands in Lake, Chaffee, Freemont and Custer Counties and portions of Pueblo and Huerfano Counties as well as part of the San Isabel National Forest. Figure VI-1 illustrates as a percentage ownership portions encompassing the procurement area as well as accessible acreage within these areas. Table VI-1 lists acreage totals for each ownership.

The timber supply in terms of allowable cut, current cut and recommended annual cut were obtained from CSU Project #2192. The raw material supply, as displayed in Table VI-2, illustrates the cut possibilities.

The four alternatives for this case study will display the individual input values which represent the four sets of overriding goals. The constraints represent types and levels of timber cut per species and mill capacities for various products with a standard revenue per product for all alternatives.

Production capability is shown in Table VI-3, with table VI-4 displaying current annual production for area mills. A definition of the products

produced in the Canon City-Florence-Penrose center and their respective conversion factors is shown in Table VI-5. This table displays the product's standard finished size, the amount of wood per product and in appropriate cases a conversion from cubic feet of product to board feet.

The results of implementing each alternative are individually briefed in Tables VI-6 through VI-9. The tables show the constraints and goals for each goal program run. Raw material supply as well as product capacity, reflective of the above constraints are also shown.

Resources used from different material classes are also displayed adjacent to raw material available in the form of percentages in Table VI-10. Thus by examining the output strictly in terms of supply the observer may determine the impact of a certain alternative strategy on the consumption of a certain size and species class of timber relative to others.

The total amount of each material class is broken down into ultimate products in Table VI-11. The total residual due to the allocation of raw materials to given products is illustrated in Table VI-12. The table sums values for given numbers of products sold in a market area by raw material class. The material classes here are grouped into ponderosa pine live which includes sawtimber and poletimber; ponderosa pine dead which includes dead <5 years and >5years and spruce-fir and lodgepole materials grouped together.

Table VI-13, returns to stumpage, shows the total residual value distribution in each alternative by material class, enabling the observer to quickly note what amount, for example, of a total residual is due to dead and beetle-killed ponderosa pine.

FIGURE VI-1 - Canon City-Florence-Penrose Tributary Area

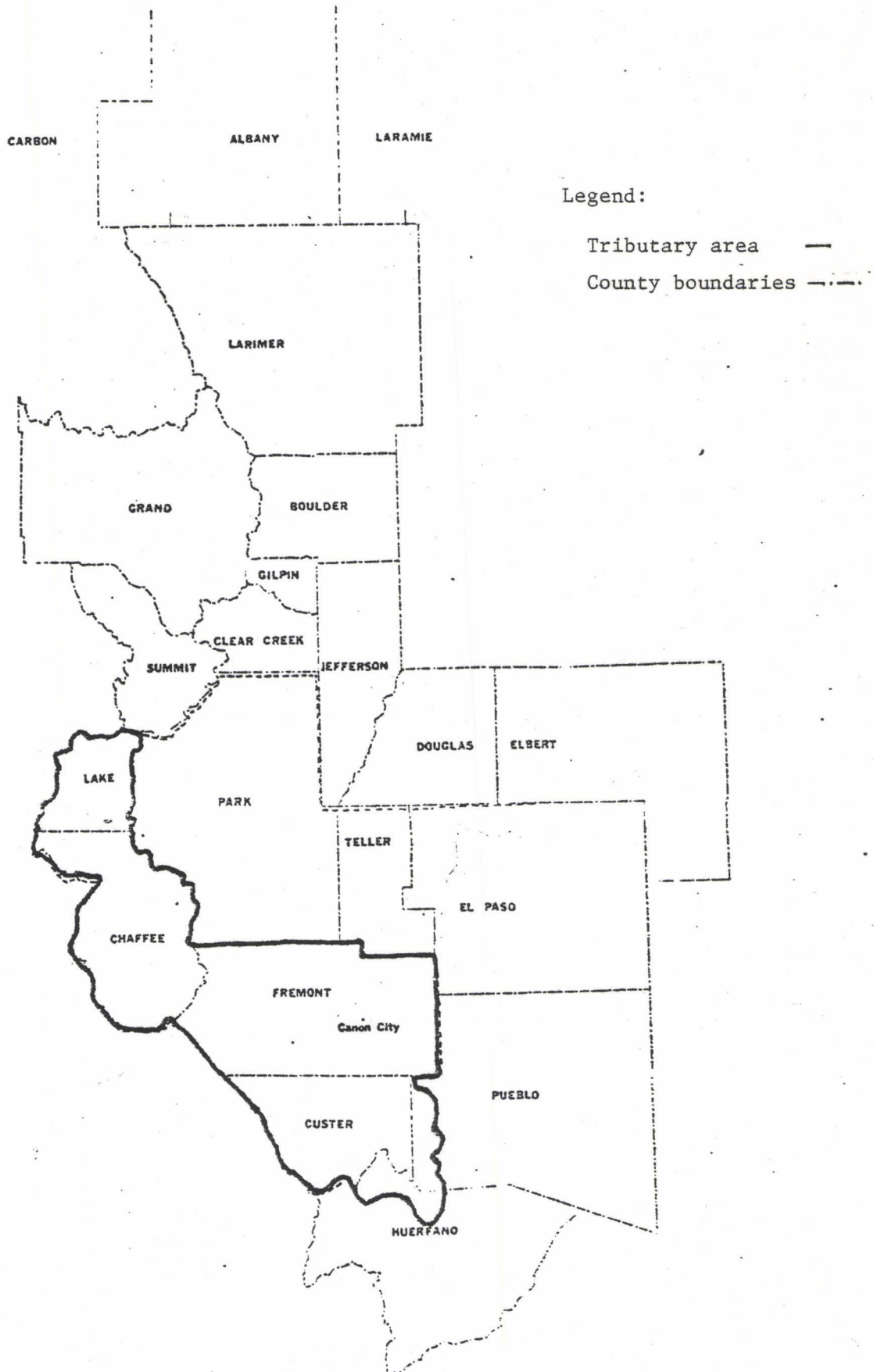
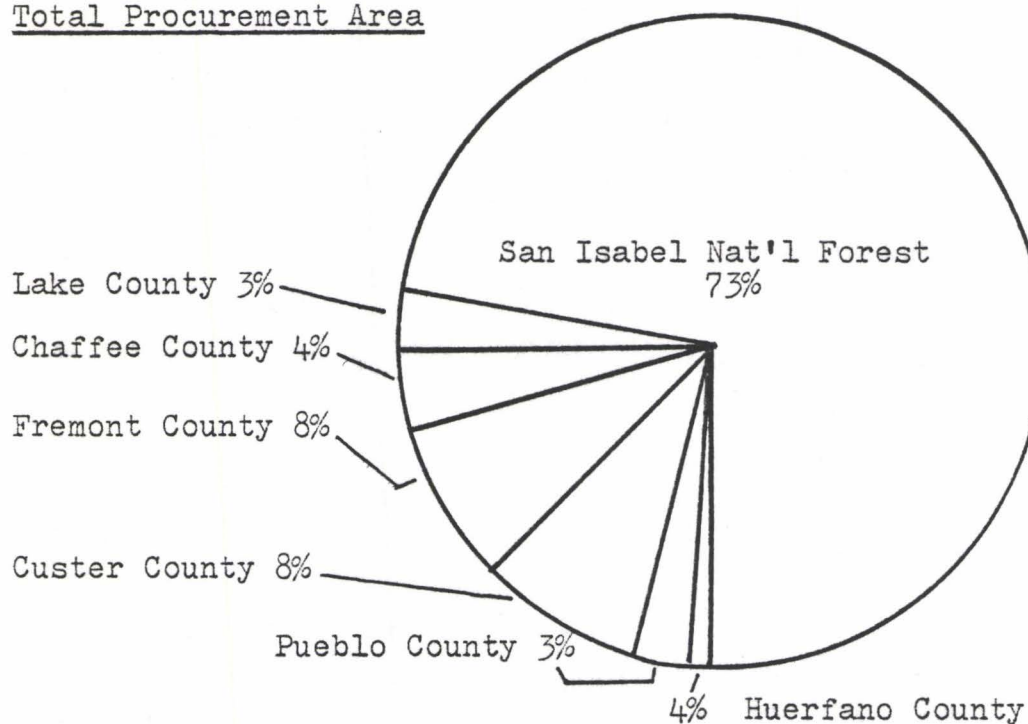


Figure VI-11 -Canon City-Penrose-Florence
Timber Procurement Area

Total Procurement Area



Accessible Commercial Area

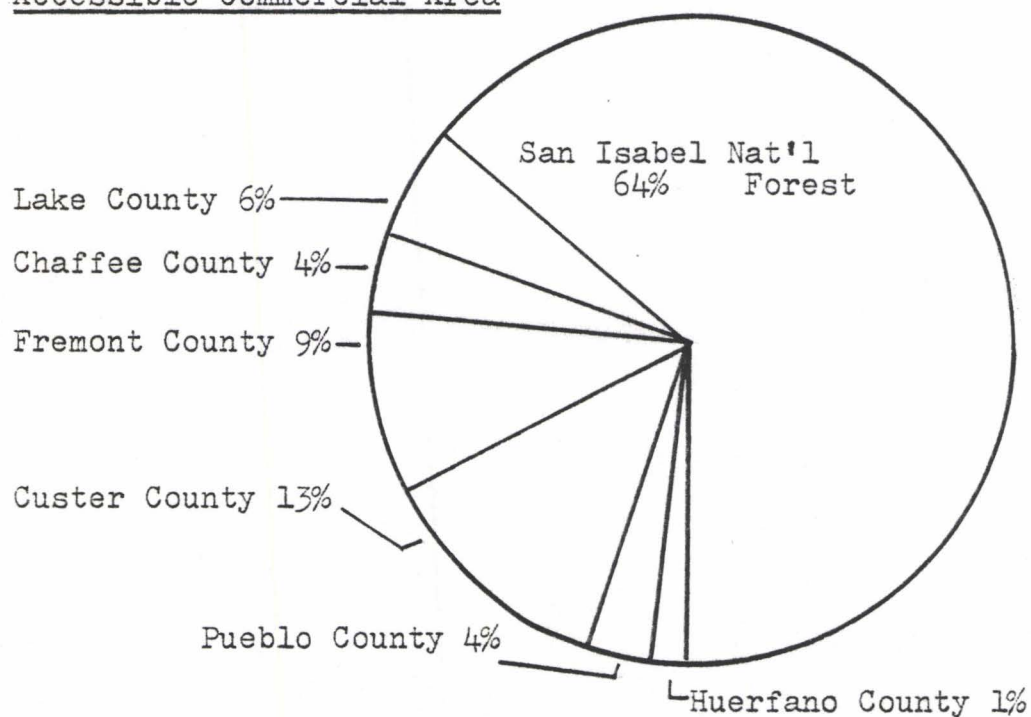


TABLE VI-1 - Canon City-Penrose-Florence

Timber Procurement Area

PROCUREMENT AREA:

San Isabel National Forest:	761,880 acres
Lake County (State & Private):	27,300
Chaffee County (State & Private):	44,300
Fremont County (State & Private):	83,800
Custer County (State & Private):	79,600
Pueblo County (State & Private):	32,400
Huerfano County (State & Private):	<u>4,500</u>
Total:	1,033,780 acres (Forested)

(forested acres, at least 10% stocked)

ACCESSIBLE COMMERCIAL FOREST LANDS - PROCUREMENT AREA:^{1/}

San Isabel National Forest:	259,705 acres
Lake County (State & Private):	23,515
Chaffee County (State & Private):	14,400
Fremont County (State & Private):	37,400
Custer County (State & Private):	51,000
Pueblo County (State & Private):	17,600
Huerfano County (State & Private):	<u>3,820</u>
Total:	407,440 acres

^{1/} Standard and special component areas on national forest land, all state and private lands.

TABLE VI-2 - Canon City-Penrose-Florence
Raw Material Supply

Allowable Cut

(Procurement Area 1,033,780 acres) (Based on Potential Yield)

<u>Species</u>	<u>Size Class</u>	<u>bdf/</u> <u>cuft</u>	<u>Allowable</u> <u>Cut (1977)</u>	<u>bdf/</u> <u>cuft</u>	<u>Products</u>
Spruce-fir	Sawtimber	5/1	1,739 MCF	10/1	869 MCF
Spruce-fir	Poletimber	"	1,165	5/1	1,165
Lodgepole	Sawtimber	"	580	10/1	290
Lodgepole	Poletimber	"	388	5/1	388
Ponderosa Pine	Sawtimber	"	580	10/1	290
Ponderosa Pine	Poletimber	"	388	5/1	388

Current Cut

<u>Species</u>	<u>Size Class</u>	<u>bdf/</u> <u>cuft</u>	<u>Current</u>	<u>bdf/</u> <u>cuft</u>	<u>Products</u>
Spruce-fir	Sawtimber	5/1	485 MCF	10/1	242 MCF
Spruce-fir	Poletimber	"	121	5/1	121
Lodgepole	Sawtimber	"	162	10/1	81
Lodgepole	Poletimber	"	40	5/1	40
Ponderosa Pine	Sawtimber	"	162	10/1	81
Ponderosa Pine	Poletimber	"	40	5/1	40

Recommended Cut

<u>Species</u>	<u>Size Class</u>	<u>bdf/</u> <u>cuft</u>	<u>Recommended</u>	<u>bdf/</u> <u>cuft</u>	<u>Products</u>
Ponderosa Pine	Sawtimber	5/1	2,481 MCF	10/1	1,240 MCF
Ponderosa Pine	Poletimber	"	384	5/1	384
PP (D<5 years)	-	"	245	8/1	151
PP (D>5 years)	-	"	153	5/1	153

TABLE VI-3 -Canon City-Penrose-Florence

Maximum Mill Production Capacity 1/

<u>Product</u>	<u>Output Capacity</u>	<u>Output Capacity</u>
Pallets	156.4 MFC (of product)	312.8 MCF (of roundwood)
Dunnage	156.4	312.8
Timbers	39.1	78.2
Rough boards	215.1	430.2
Fence posts	8.6	8.6
Dimension lumber	29.3	58.6
Firewood	153.0	248.2
Railroad	78.2	156.4
Chips	356.0	
Sawdust	173.9	
Shavings	1.5	

1/ based on an 8 hr. day 240 days/yr.

TABLE VI-4 -Canon City-Penrose-Florence

Current Annual Product Production

<u>Product</u>	<u>Output</u>	<u>Output</u>
Pallets	50.8 MCF (of product)	101.6 MCF (of roundwood)
Dunnage	78.2	156.4
Timbers	23.5	47.0
Rough boards	59.6	119.2
Fence posts	8.6	8.6
Dimension lumber	16.6	33.2
Firewood	38.2	62.0
Railroad	5.8	11.6
Chips	123.8	
Sawdust	60.4	
Shavings	1.5	

TABLE VI-5 - Canon City-Penrose-Florence
Product Definition and Conversion Factors

Pallets	4'x4'	20 bdft/pallet	81.47 cuft/MBF
Dunnage	4'x4'	20 bdft/dunnage	81.47 cuft/MBF
Timbers	6"x6"x8'	not treated	81.47 cuft/MBF
Rough boards (x)	1"x4"		81.47 cuft/MBF
Fence posts	3.5"x6.5'	.43 cuft/post	treated
Dimension lumber	3"x6"		81.47 cuft/MBF
Firewood	4'x4'x8'	85 cuft/cord	
Railroad	6"x4"x6'	1 cuft/tie	untreated
Chips	43 cuft/MBF	25 lbs/cuft	
Sawdust	21 cuft/MBF		
Shavings	16 cuft/MBF		

TABLE VI-6 - Canon City-Penrose-Florence

Alternative #1 Description

Constraints: - annual allowable cut on SF-LP
 - recommended PP cut
 - annual cut on mortality PP and salable dead
 - product capacity for each product

Goal: #1 - minimize underachievement of recommended PP cuts
 #2 - maximization of returns to stumpage

Raw Material Supply:	(MCF of roundwood)	Resources Used:	(MCF of roundwood)
SF-LP sawtimber	2318.0		0.0
SF-LP poletimber	1553.0		0.0
PP sawtimber	2480.0		1349.0
PP poletimber	384.0		8.6
PP dead<5 yrs	245.0		245.0
PP dead>5 yrs	<u>153.0</u>		<u>2.0</u>
	7133.0 MCF		1604.6 MCF

Maximum Mill Production Capacity: (MCF of roundwood)

pallets	312.8
timbers	78.2
rough boards	430.2
fence posts	8.6
dimension lumber	58.6
firewood	248.1
railroad ties	156.4
dunnage	312.8

SF-LP = spruce-fir, lodgepole pine

PP = ponderosa pine

Table VI-7 - Canon City-Penrose-Florence

Alternative #2 Description

Constraints: - annual allowable cut on SF, LP, PP
 - recommended annual cuts on mortality and salable dead

Goals: #1 - minimize underachievement of removing previous year
 PP mortality
 #2 - maximize returns to stumpage

	<u>Raw Material Supply:</u> <u>(MCF of roundwood)</u>	<u>Resources Used:</u> <u>(MCF of roundwood)</u>
SFLP sawtimber	2318.0	1064.2
SF-LP poletimber	1553.0	0.0
PP sawtimber	580.0	0.0
PP poletimber	388.0	0.0
PP dead <5 yrs	245.0	245.0
PP dead >5 yrs	<u>153.0</u>	<u>153.0</u>
TOTAL	5237.0 MCF	1462.2 MCF

Maximum Mill Production Capacity: (MCF of roundwood)

pallets	312.8
timbers	78.2
roudh boards	430.2
fence posts	8.6
dimension lumber	58.6
firewood	248.2
railroad ties	156.4
dunnage	312.8

Table IV-8 - Canon City-Penrose-Florence

Alternative #3 Description

Constraints: - annual allowable cuts on SF, LP, PP
 - recommended annual cut on mortality PP and salable dead

Goals: #1 - maximization of returns to stumpage

	Raw Material Supply: (MCF of roundwood)	Resources Used: (MCF of roundwood)
SF-LP sawtimber	2318.0	1349.0
SF-LP poletimber	1553.0	8.6
PP sawtimber	580.0	0.0
PP poletimber	388.0	0.0
PP dead <5 yrs	245.0	245.0
PP dead >5 yrs	<u>153.0</u>	<u>2.0</u>
TOTAL	5237.0 MCF	1604.6 MCF

Maximum Mill Production Capacity:

pallets	312.8
timbers	78.2
rough borads	430.2
fence posts	8.6
dimension lumber	58.6
firewood	248.2
railroad ties	156.4
dunnage	312.8

Table VI-9 - Canon City-Penrose-Florence

Alternative #4 Description

Constraints: - current cut level for LP, SF, PP
 - redommed annual cut for mortality PP and salable dead
 - current annual production levels for each product

Goals: #1 - maximization of returns to stumpage

Raw Material Supply: (MCF of roundwood) Resources Used: (MCF of roundwood)

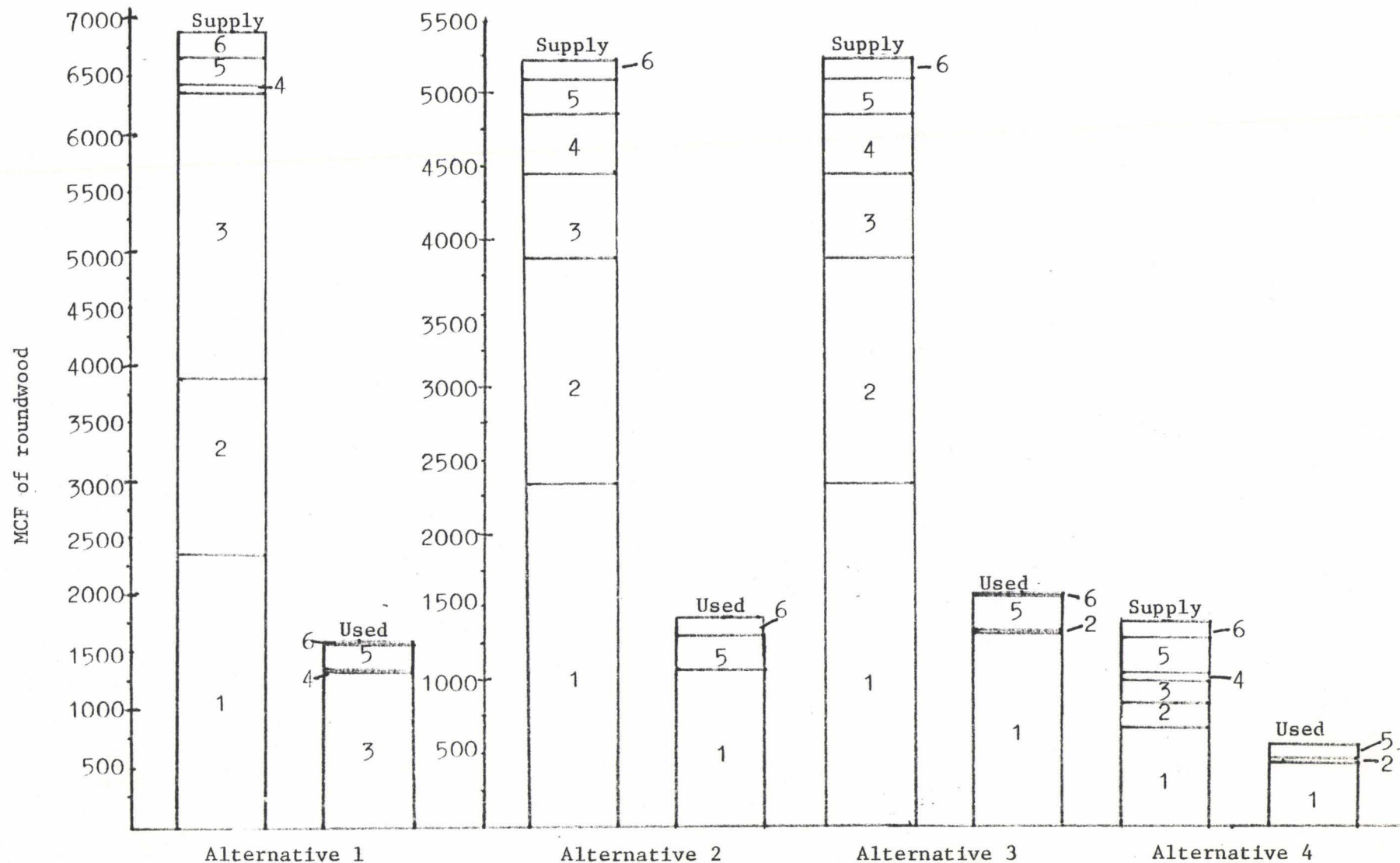
SF-LP sawtimber	646.0	469.0
SF-LP poletimber	161.0	8.6
PP sawtimber	162.0	0.0
PP poletimber	40.0	0.0
PP dead <5 yrs	245.0	62.0
PP dead >5 yrs	<u>155.0</u>	<u>0.0</u>
TOTAL	1407.0 MCF	559.6 MCF

Current Mill Production:

pallets	101.6
timbers	47.0
rough boards	119.2
fence posts	8.6
dimension lumber	33.2
firewood	62.0
railroad ties	11.6
dunnage	156.4

TABLE VI-10 - Canon City-Florence-Penrose

Raw Material Supply versus Raw Material Consumed



1=Spruce-fir, lodgepole sawtimber
2= Spruce-fir, lodgepole poletimber

3=Ponderosa pine sawtimber
4=Ponderosa pine poletimber

5=Ponderosa, dead 5<yrs.
6=Ponderosa, dead 5>yrs.

FIGURE VI-3 - Marketing Area for Canon City-Florence-Penrose Processing Center

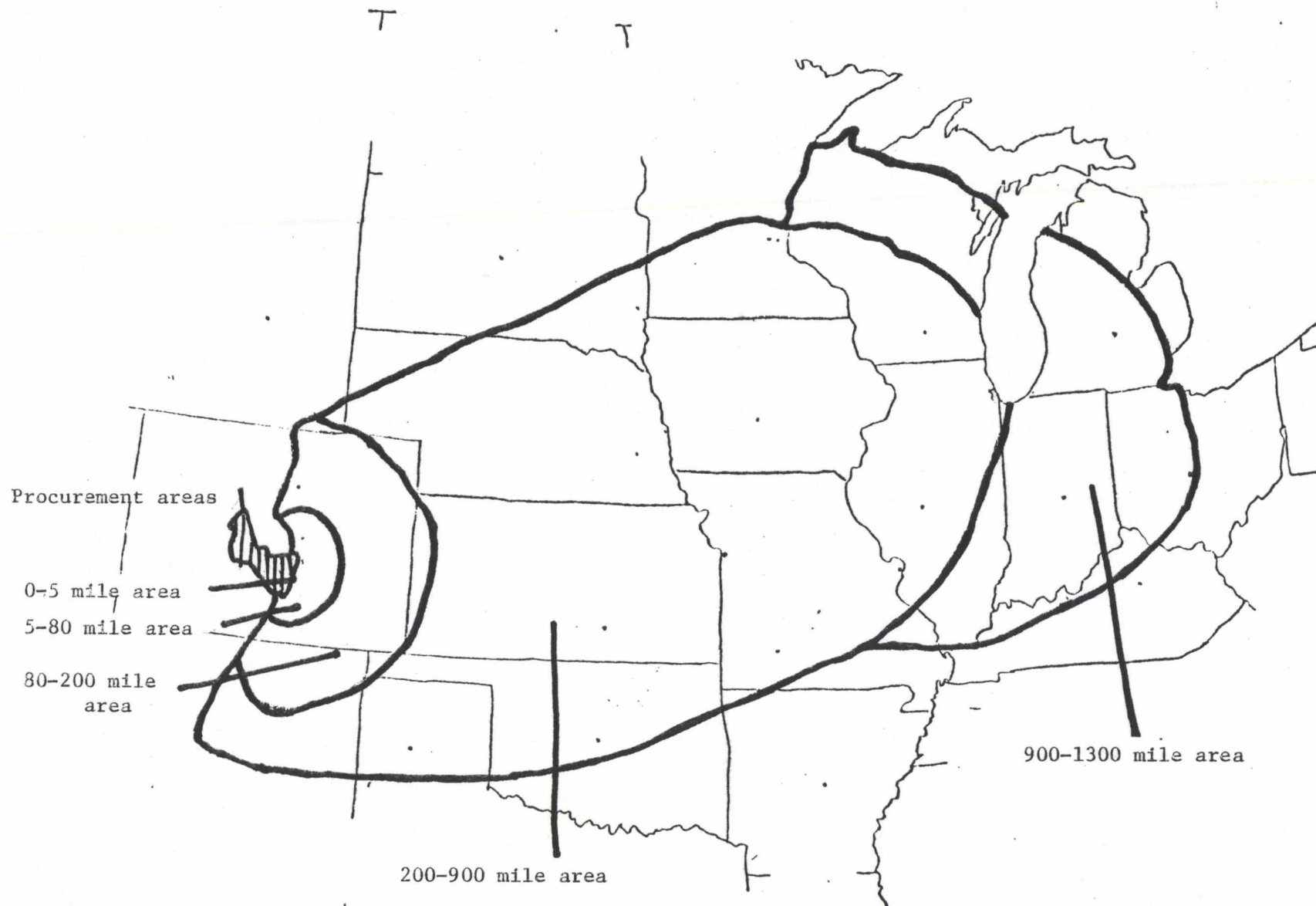


FIGURE VI-4 - Transportation Isocost Map and Marketing Area for Canon City-Florence-Penrose

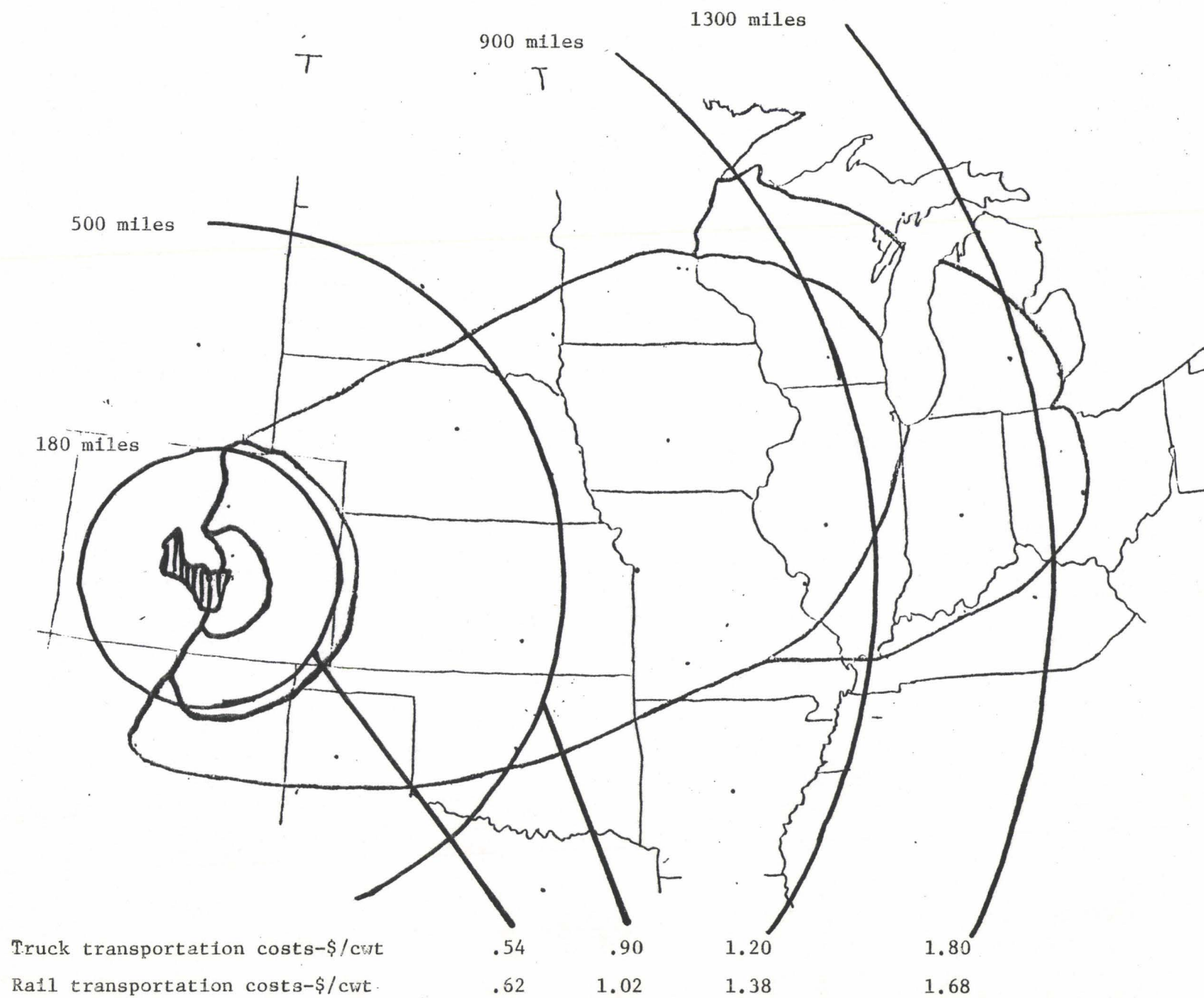


TABLE VI-11 - Canon City-Penrose-Florence

Market Consumption: Resources to Products (in MCF of roundwood)--No Market Demand Restrictions

	Alternative 1		Alternative 2		Alternative 3		Alternative 4	
0-5 Mile	Pallets (PP)	312.8	Pallets (D<5)	231.0	Pallets (SFLP)	312.8	Pallets (SFLP)	101.6
	Timbers (PP)	78.2	Pallets (SFLP)	28.0	Timbers (SFLP)	78.2	Timbers	47.0
	Boards R (PP)	430.2	Timbers (SFLP)	78.2	Boards R (SFLP)	430.2	Boards R (SFLP)	119.2
	Fence posts (PP)	8.6	Boards R (SFLP)	430.2	Fence posts (SFLP)	8.6	Fence posts (SFLP)	8.6
	Dimension L (PP)	58.6	Fence posts (D<5)	8.6	Dimension L (SFLP)	58.6	Dimension L (SFLP)	33.2
	Firewood (D<5)	245.0	Dimension L (SFLP)	58.6	Firewood (D<5)	245.0	Firewood (D<5)	62.0
	Firewood (D>5)	2.0	Firewood (D>5)	153.0	Firewood (D>5)	2.0	Railroad ties	
	Railroad ties		Railroad ties		Railroad ties		(SFLP)	11.6
	(PP)	156.4	(SFLP)	156.4	(SFLP)	156.4	Dunnage (SFLP)	156.4
	Dunnage (PP)	312.8	Dunnage (SFLP)	312.8	Dunnage (SFLP)	312.8	Chips	123.8
	Chips*	356.14	Chips	356.14	Chips	356.14	Sawdust	60.3
	Sawdust	173.4	Sawdust	173.4	Sawdust	173.4	Shavings	1.6
	Shavings	1.6	Shavings	1.6	Shavings	1.6		

* Chips, sawdust, and shavings are in units of MCF of product residue, not roundwood residue.

PP = Ponderosa Pine. SFLP - Spruce-fir, Lodgepole Pine. D<5 = Ponderosa Pine dead <5 yrs.

D>5 = Ponderosa Pine dead >5 yrs.

TABLE VI-12 - Canon City-Penrose-Florence

Total Residual Distribution Per Market Zone and
Alternative 1/

0-5 Mile Area

Alternative #1	Total residual Due to live PP Due to dead PP Due to SFLP	\$217,075.86 211,764.70 3,187.00 0.00
Alternative #2	Total residual Due to live PP Due to dead PP Due to SFLP	235,693.06 0.00 83,085.00 150,483.90
Alternative #3	Total residual Due to live PP Due to dead PP Due to SFLP	248,214.46 0.00 3,187.00 242,930.03
Alternative #4	Total residual Due to live PP Due to dead PP Due to SFLP	101,130.16 0.00 802.20 99,585.40

1/ As chips, shavings, and sawdust were consumed in the 0-5 mile area in each alternative, their respective values are included in these total residual figures.

TABLE IV-13 - Canon City-Penrose-Florence

Returns to Stumpage

	Revenue due to live PP	Revenue due to dead PP	Revenue due to SFLP	Revenue due to Residues	Total Revenue
Alternative 1	\$211,764.70	3,187.00	0.00	2124.16	\$217,075.86
Alternative 2	0.00	83,085.00	150,483.90	2124.16	235,693.06
Alternative 3	0.00	3,187.00	242,903.30	2124.16	248,214.46
Alternative 4	0.00	802.20	99,585.40	742.56	101,130.16

TABLE VI-14 - Canon City-Florence-Penrose
Mills Marginal Revenues, Marginal Costs,
Profit & Risk, and Residual

$$MR - MC - P + R = R^*$$

MR (Wholesale Price)

MC (Stumpage Costs + Procurement Costs + Milling Costs + Transportation to Market Costs)

P+R (10% of MC for Profit + Risk)

R (Residual)

* (When R is less than 0, the product is considered uneconomical to market in the marketing area)

KEY

- 1) If there is no symbol in front of the product, it is currently marketed and is considered economical.
- 2) * means the product is currently marketed and is considered uneconomical based on the above R calculation.
- 3) ** means the product is not currently marketed, but is considered economical to the market.
- 4) *** means the product is not currently marketed, and is considered uneconomical.

(PP) Ponderosa Pine

(LP) Lodgepole Pine

(SF) Spruce-fir

(D<5) Ponderosa Pine that has been dead for five years or less.

Chips (D) = chips from dead wood

Chips (G) = chips from green wood

Table VI-14 - Canon City-Florence-Penrose

0-5 Mile Marketing Area

<u>Products</u>	<u>MR</u> <u>MCF</u>	<u>MC</u> <u>MCF</u>	<u>P & R</u>	<u>Residual</u> <u>MCF</u>
Pallets (PP)	3000	2254	225	521
Pallets (LP) & (SF)	3000	2212	221	567
Pallets (D<5 yr)	300	2278	228	494
Dunnage (PP)	3000	2254	225	521
Dunnage (LP) & (SF)	3000	2212	221	567
Dunnage (D<5 yr)	3000	2278	228	494
Timbers (PP)	1920	1653	165	102
Timbers (LP)	1920	1611	161	148
Timbers (SF)	1920	1611	161	148
Timbers (D<5 yr)	1920	1677	168	76
Boards R (PP)	1800	1532	153	115
Boards R (LP) & (SF)	1800	1490	149	161
Boards R (D<5 yr)	1800	1556	156	88
Fence Posts (PP)	4069	2476	248	1345
Fence Posts (LP) & (SF)	4069	2465	246	1358
Fence Posts (D<5 yr)	4069	2482	248	1339
Dimension L. (PP)	2400	2180	218	2
Dimension L. (LP) & ()	2400	2138	214	48
*Dimension L. (D<5 yr)	2400	2204	220	-24
Firewood (D<5 yr)	529	462	46	21
Firewood (D>5 yr)	529	474	47	8
RR Ties (PP)	1860	1593	159	108
RR Ties (LP) & (SF)	1860	1551	155	154
RR Ties (D<5 yr)	1860	1640	164	56
Chips (D)	50	42	4	4
Chips (G)	50	42	4	4
Shavings	50	42	4	4
Sawdust	50	42	4	4

5-80 Mile Marketing Area

<u>Products</u>	<u>MR MCF</u>	<u>MC MCF</u>	<u>P & R</u>	<u>Residual MCF</u>
Pallets (PP)	3000	2352	235	413
Pallets (LP) & (SF)	3000	2310	231	459
Pallets (D<5)	3000	2376	238	386
Dunnage (PP)	3000	2352	235	413
Dunnage (LP) & (SF)	3000	2310	231	459
Dunnage (D<5)	3000	2376	238	386
Timbers (PP)	1920	1746	174	0
Timbers (LP) & (SF)	1920	1704	170	46
*Timbers (D<5)	1920	1770	177	-27
**Boards R (PP)	1800	1584	158	58
**Boards R (LP) & (SF)	1800	1542	154	104
**Boards R (D<5)	1800	1608	161	31
Fence P (PP)	4069	2561	256	1252
Fence P (LP) & (SF)	4069	2550	255	1264
Fence P (D<5)	4069	2567	257	1245
***Dimension L. (PP)	2400	2232	223	-55
***Dimension L. (LP) & (SF)	2400	2190	219	-9
***Dimension L. (D<5)	2400	2256	226	-82
***Firewood (D<5)	529	819	82	-372
***Firewood (D>5)	529	831	83	-385
RR Ties (PP)	1860	1686	169	5
RR Ties (LP) & (SF)	1860	1644	164	52
*RR Ties (D<5)	1860	1710	171	-21
*Chips (G & D)	37	138	14	-115
*Shavings	37	138	14	-115
*Sawdust	37	138	14	-115

80-200 Mile Marketing Area

<u>Products</u>	<u>MR/MCF</u>	<u>MC/MCF</u>	<u>P & R</u>	<u>Residual/MCF</u>
** Pallets (PP)	3000	2537	254	209
** Pallets (LP & SF)	3000	2495	249	256
** Pallets (D<5)	3000	2561	256	183
** Dunnage (PP)	3000	2537	254	209
** Dunnage (LP & SF)	3000	2495	250	256
** Dunnage (D<5 yr)	3000	2561	256	183
Timbers (PP)	2100	1874	187	39
Timbers (LP & SF)	2100	1832	183	85
Timbers (D<5yr)	2100	1898	190	12
Fence P	3720	2768	277	675
Fence P (LP & SF)	3720	2757	256	707
Fence P (D<5)	3720	2774	277	669
RR Ties (PP)	2100	1814	181	105
RR Ties (LP & SF)	2100	1772	177	151
RR Ties (D<5 yr)	2100	1838	184	78
*** Boards R (All)	-	-	-	- (Very High)
*** Dimension L. (All)	-	-	-	- (Very High)
*** Firewood (All)	-	-	-	- (Very High)
*** Chips (All)	-	-	-	- (Very High)
*** Shavings	-	-	-	- (Very High)
*** Sawdust	-	-	-	- (Very High)

200-900 Mile Marketing Area

<u>Products</u>	<u>MR/MCF</u>	<u>MC/MCF</u>	<u>P & R</u>	<u>Residual/MCF</u>
Fence P (PP)	4069	3602	360	107
Fence P (LP & SF)	4069	3591	359	119
Fence P (D<5)	4069	3608	361	100
*** Other Products	-	-	-	- (Very High)

900-1300 Mile Marketing Area

*** Chips (D & G)	244	232	23	-11
*** Other Products	-	-	-	- (Very High)

Table VI-15 - Cost Breakdown Sheet for Canon City-Florence-Penrose Processing Area

Products		Stumpage ¹		Procurement		Milling		P&R %	Transp.	Transp.	Transp.
		MBF	MCF	MBF	MCF	MBF	MCF		(0-5) MCF	(5-80) MCF	(80-200) MCF
	Pallets (PP)	3.00	36.00	64.51	774	119.99	1440	.10	4.00	102.45	286.88
	Pallets (LP)	4.00	48.00	60.01	720	"	"	"	"	"	"
	Pallets (SF)	"	"	"	"	"	"	"	"	"	"
	Pallets (D 5 yrs)	.50	6.00	69.01	828	"	"	"	"	"	"
	Dunnage (PP)	3.00	36.00	64.51	774	119.99	1440	.10	4.00	102.45	286.88
	Dunnage (LP)	4.00	48.00	60.01	720	"	"	"	"	"	"
	Dunnage (SF)	"	"	"	"	"	"	"	"	"	"
	Dunnage (D 5 yrs)	.50	6.00	69.01	828	"	"	"	"	"	"
Not Treated	Timbers (PP)	3.00	36.00	64.51	774	70.00	840	.10	3.20	96.15	224.35
	Timbers (LP)	4.00	48.00	60.01	720	"	"	"	"	"	"
	Timbers (SF)	"	"	"	"	"	"	"	"	"	"
	Timbers D 5 yrs)	.50	6.00	69.01	828	"	"	"	"	"	"
	Boards R (PP)	3.00	36.00	64.51	774	59.99	720	.10	1.80	54.00	-
	Boards R (LP)	4.00	48.00	60.01	720	"	"	"	"	"	-
	Boards R (SF)	"	"	"	"	"	"	"	"	"	-
	Boards R (D 5 yrs)	.50	6.00	69.01	828	"	"	"	"	"	-
	Fence posts (PP)	2.00	24.00	41.37	496	162.73	1953	.10	3.22	88.06	295.14
	Fence posts (LP)	3.00	36.00	39.40	473	"	"	"	"	"	"
	Fence posts (SF)	"	"	"	"	"	"	"	"	"	"
	Fence posts (D 5)	.50	6.00	43.34	520	"	"	"	"	"	"
	Dimension L (PP)	3.00	36.00	64.51	774	114	1368	.10	1.80	54.00	160.00
	Dimension L (LP)	4.00	48.00	60.01	720	"	"	"	"	"	"
	Dimension L (SF)	"	"	"	"	"	"	"	"	"	"
	Dimension L (D 5)	.50	6.00	69.01	828	"	"	"	"	"	"

Transp. (200-900) MCF	Transp. (900-1300) MCF	Product V ² (0-5) MBF MCF		Product V (5-80) MBF MCF		Product V (80-200) MBF MCF		Product V (200-900) MBF MCF		Product V (900-1300) MBF MCF	
-	-	250	3000	250	3000	250	3000	250	3000	-	-
-	-	"	"	"	"	"	"	"	"	-	-
-	-	"	"	"	"	"	"	"	"	-	-
-	-	"	"	"	"	"	"	"	"	-	-
-	-	250	3000	250	3000	250	3000	250	3000	-	-
-	-	"	"	"	"	"	"	"	"	-	-
-	-	"	"	"	"	"	"	"	"	-	-
-	-	"	"	"	"	"	"	"	"	-	-
-	-	160	1920	160	1920	175	2100	-	-	-	-
-	-	"	"	"	"	"	"	-	-	-	-
-	-	"	"	"	"	"	"	-	-	-	-
-	-	"	"	"	"	"	"	-	-	-	-
-	-	150	1800	150	1800	145	1740	-	-	-	-
-	-	"	"	"	"	"	"	-	-	-	-
-	-	"	"	"	"	"	"	-	-	-	-
-	-	"	"	"	"	"	"	-	-	-	-
1129	-	339	4069	339	4069	310	3720	339	4069	-	-
"	-	"	"	"	"	"	"	"	"	-	-
"	-	"	"	"	"	"	"	"	"	-	-
"	-	"	"	"	"	"	"	"	"	-	-
-	-	200	2400	200	2400	210	2520	-	-	-	-
-	-	"	"	"	"	"	"	-	-	-	-
-	-	"	"	"	"	"	"	-	-	-	-
-	-	"	"	"	"	"	"	-	-	-	-

Table VI-15 (Continued)

Products		Stumpage		Procurement		Milling		P&R	Transp.	Transp.	Transp.
		MBF	MCF	MBF	MCF	MBF	MCF	%	(0-5) MCF	(5-80) MCF	(80-200) MCF
Firewood (D 5)		.50	6.00	36.50	438	0	0	.10	17.60	375	-
Firewood (D 5)		"	"	37.50	450	"	"	"	"	"	-
Not Treated	RR Ties (PP)	3.00	36.00	64.51	774	65.00	780	.10	3.20	96.15	224.35
	RR Ties (LP)	4.00	48.00	60.01	720	"	"	"	"	"	"
	RR Ties (SF)	"	"	"	"	"	"	"	"	"	"
	RR Ties (D 5)	.50	6.00	69.01	828	"	"	"	"	"	"
Chips (D)		-	-	-	-	3.00	36.00	.10	5.81	101.74	349.00
Chips (G)		-	-	-	-	"	"	"	"	"	"
Shavings		-	-	-	-	3.00	36.00	.10	5.81	101.74	349.00
Sawdust		-	-	-	-	3.00	36.00	.10	5.81	101.74	349.00

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¹All figures are \$/MBF and \$/MCF as indicated

²PRODUCT V - (product value) refers to the marginal revenue from a product in a given market zone

Transp. (200-900) MCF	Transp. (900-1300) MCF	Product V (0-5)		Product V (5-80)		Product V (80-200)		Product V (200-900)		Product V (900-1300)	
		MBF	MCF	MBF	MCF	MBF	MCF	MBF	MCF	MBF	MCF
-	-	44	529	44	529	56	670	-	-	-	-
-	-	"	"	"	"	"	"	-	-	-	-
-	-	155	1860	155	1860	175	2100	-	-	-	-
-	-	"	"	"	"	"	"	-	-	-	-
-	-	"	"	"	"	"	"	-	-	-	-
-	-	"	"	"	"	"	"	-	-	-	-
-	195.9	-	49.76	-	37.0	-	112	-	-	-	244
-	"	-	"	-	"	-	"	-	-	-	"
-	-	-	49.76	-	37.0	-	112	-	-	-	-
-	-	-	49.76	-	37.0	-	112	-	-	-	-

CASE STUDY VI - Canon City-Florence-Penrose Tributary Area Summary
Analysis

Raw Material Versus Amount Consumed

In each of the alternatives the raw material supply was found to exceed the current and maximum levels of consumption.

Supply - Consumption Differential				
Alternative	1	2	3	4
	5228.4	3774.8	3632.4	867.4 MCF

As in other case studies, alternative 1 contained the highest available supply left over due to the large recommended ponderosa pine cut called for in the constraints. Considerable amounts of raw material supply are left, remaining after processing center consumption due to limited production capacities. The supply consumed will be examined in later sections of this summary.

Utilization of all Ponderosa Pine Types

The raw material information below is taken from Tables VI-6, 7, 8 and 9 and reflect the cutting schedules as depicted in each table.

Alternative	1	2	3	4
ponderosa pine supply (MCF)	2962.0	1366.0	1366.0	600.00
ponderosa pine used (MCF)	1604.6	398.0	247.0	62.0

The high quantities of ponderosa pine used are in response to goals and constraints which emphasize its use. In alternative 1 the majority of the pine consumed is sawtimber, and as in the second and third alternatives, the complete supply of beetle-killed ponderosa pine dead <5 years is consumed. For each case, dead <5 years was consumed as firewood and consumed in the first marketing zone.

Alternative 2 was the only one to utilize the entire dead >5 years supply, and it was used for firewood. Alternatives 1 and 3 utilized a very small amount of dead >5 years, 2 MCF, and alternative 4 left its supply untouched.

Utilization of Beetle-Killed Ponderosa Pine

As was cited above, alternative 2 was the only alternative to exhaust its supply of beetle-killed wood. Of the four alternatives, all except #4 used a fairly high percentage of that available as illustrated.

Alternative	1	2	3	4	
beetle-killed supply	398.0	398.0	398.0	398.0	MCF
beetle-killed used	247.0	398.0	247.0	62.0	MCF

Without restriction on material type usage in most instances beetle-killed wood dead <5 years was found to be the preferred raw material type after spruce-fir and lodgepole pine.

Overall Returns to Stumpage

A review of the table on the next page will assist in illustrating the results of the alternatives in terms of raw material utilization and revenue potentials.

Alternative 3 yields the highest overall revenue due to its unrestrictive goal of maximizing returns. As a result of a high proportion of spruce-fir, lodgepole pine products gave the highest residual returns. Alternative 1's ponderosa pine supply was sufficient to 100% of total revenue. But because of strict use of ponderosa pine this total revenue figure was moderately lower than alternatives 2 and 3. Alternative 2 exhausted its total beetle-killed pine supply, as per the #1 goal resulting in a fairly high, 35% of total profits. This material was consumed as pallets, fence posts and firewood.

Alternative	1	2	3	4
Ponderosa Pine as % of Total Supply	43.3	26.1	26.1	42.6
Ponderosa Pine as % of Total Used	100	27.2	15.4	11.5
Revenue as a % of Total	99.0	35.2	1.3	0.8
Spruce-fir, lodgepole as % of Total Supply	56.7	73.9	73.9	57.4
Spruce-fir, lodgepole as % of Total Used	0.0	72.8	84.6	88.5
Revenue as a % of Total	0.0	63.8	97.9	98.5
TOTAL REVENUE*	\$217.075	235,693	248,214	101,130

* Total revenue includes revenue due to mill residues

In alternative 3 ponderosa pine composed 15% of total supply but only 1.3% of total revenue. This was a result of the use of spruce-fir, lodgepole pine for higher return products leaving ponderosa pine beetle-killed wood for use as low return firewood.

Market Consumption of Products

All products produced in the Canon City processing area are found to be marketed in the first zone due to lower production capacities and higher returns, in general, in the first zone. Thus a great potential obviously remains for increased production. While some products do maintain substantial residual values at greater distances from the center, transportation costs associated with them frequently result in lower returns per MCF of product.

Optimum Ponderosa Pine Utilization

The highest potential for utilization of ponderosa pine, as in other cases, is found in alternative 1, this is primarily in the form of live ponderosa pine. Alternative 2 yields the highest return due strictly to dead ponderosa pine material but produces no products from live ponderosa pine at all. Products which maximize returns from live ponderosa pine in alternative 1 and dead ponderosa pine in alternative 2 are listed.

Products from live ponderosa pine

All products produced
in the processing
center

Products from dead ponderosa pine

pallets
fence posts
firewood

Alternative 4, the current situation, accrues only 0.8% of its total revenue to ponderosa pine, this is the form of beetle-killed pine dead <5 years. The remainder of total revenue is due to spruce-fir and lodgepole pine.

Product Profit Potentials

The examination of revenue and cost figures in Tables VI-14 and 15 have shown, in many cases, profit potentials. These products are summarized below by zone. (See Table VI-14)

5-80 mile zone

<u>Products</u>	<u>Returns to Stumpage (\$/MCF of roundwood)</u>
boards, rough-PP	29.00
boards, rough-SFLP	52.00
boards, rough-D<5	15.50

80-200 mile zone

pallets -PP	104.50
pallets - SFLP	128.00
pallets -D<5	91.50
dunnage -PP	104.50
dunnage -SFLP	128.00
dunnage -D<5	91.50

*PP=ponderosa pine, SFLP=spruce-fir, lodgepole pine, D<5=ponderosa pine dead<5 years

Several products which are presently consumed in various marketing zones. were found in this study to be presently marketed at a loss per MCF. They are listed below by market zone. (See Table VI-14)

Products Presently Marketed with Uneconomical Residual

<u>Product</u>	<u>Return to Stumpage (\$/MCF of roundwood)</u>
0-5 mile zone	
dimension lumber (D<5)	-12.00
5-80 mile zone	
timbers (D<5)	-13.50
railroad ties (D<5)	-10.50
chips	-115.00
shavings	-115.00
sawdust	-115.00

Canon City-Florence-Penrose Tributary Area

Sensitivity Analysis

As in the other tributary areas, Canon City area alternatives did not exhaust available raw material supplies. The total amount of raw materials consumed was less than that concerned in the original alternative results.

Resources Used (MCF of roundwood)

Alternative	1	2	3	4
original analysis	1604	1462	1604	539
sensitivity analysis	1329	1338	1329	454

The drop in resources used results from the product demand limitation imposed on the 0-5 mile market zone. The goal of maximizing returns causes product consumption to occur in the market zone that yields the highest return for each product-species type combination. In the original alternative runs, the entire production capacity for a product could be consumed in one market zone. Under the demand constraint, only 10% of total possible production could be consumed in the 0-5 mile zone.

In this case study, dimension lumber and firewood appear, due to their residual value only in the first zone. They were found to be uneconomical to market in any other zones. This has the effect of reducing the raw materials consumed, since only 10% of possible production is allocated to the 0-5 mile market zone and these products are not consumed in any other zones.

Raw Material Used: Original Alternatives Minus Sensitivity
(MCF of roundwood)

	ALT.1- ALT. 1-S	ALT.2- ALT. 2-S	ALT.3- ALT. 3-S	ALT.4- ALT. 4-S
SFLP sawtimber	0.0	-13.6	52.8	29.8
SFLP potetimber	0.0	0.0	0.0	0.0
PP sawtimber	52.0	0.0	0.0	0.0
PP poletimber	0.0	0.0	0.0	0.0
PP dead 5 yrs.	220.2	0.0	220.2	55.8
PP dead 5 yrs.	2.0	137.7	2.0	0.0

This has the effect of reducing total returns as compared to the original alternative results. Another factor reduces total returns. Products which are consumed in the 0-5 zone, yielding highest returns, and are also considered economical in other zones will be consumed in the zone yielding the next highest return.

Difference in Returns to Stumpage: Original Alternatives minus
Sensitivity

	0-5 mile zone	5-80 mile zone	80-200 mile zone	Total Difference
Alt.1-Alt.1-5	\$193,529	-137,170	-8765	\$47,594
Alt.2-Alt.2-5	211,532	-153,094	-15,132	43,306
Alt.3-Alt.3-5	221,560	-159,122	-13,622	48,816
Alt.4-Alt.4-5	90,323	- 68,597	-2579	19,147

As can be seen in the above table, only in the 0-5 market zone does the original analysis result in more returns than the sensitivity analysis. By examination of Tables VI-12 and VI-18, it can be seen that in the original alternatives all product consumption occurred in the 0-5 mile zone. The highest returns for all products were in this zone. Due to the demand constraint imposed on this zone for the sensitivity analysis, the products are

Table VI-16 - Canon City-Florence-Penrose: SENSITIVITY STUDY
Raw Material Supplies Versus Raw Material Used

ALTERNATIVE 1

Supply (MCF of roundwood):		Resources Used (MCF of roundwood):
SFLP sawtimber	2318.0	0.0
SFLP poletimber	1553.0	0.0
PP sawtimber	2480.0	1296.0
PP poletimber	84.0	8.6
PP dead <5 yrs	245.0	24.8
PP dead >5 yrs	153.0	0.0
TOTAL	6833.0 MCF	1329.6 MCF

ALTERNATIVE 2

Supply (MCF of roundwood):		Resources Used (MCF of roundwood):
SFLP sawtimber	2318.0	1077.8
SFLP poletimber	1553.0	0.0
PP sawtimber	580.0	0.0
PP poletimber	388.0	0.0
PP dead <5 yrs	245.0	245.0
PP dead >5 yrs	153.0	15.3
TOTAL	5237.0 MCF	1338.1 MCF

ALTERNATIVE 3

Supply (MCF of roundwood):		Resources Used (MCF of roundwood):
SFLP sawtimber	2318.0	1296.2
SFLP poletimber	1553.0	8.6
PP sawtimber	580.0	0.0
PP poletimber	388.0	0.0
PP dead <5 yrs	245.0	24.8
PP dead >5 yrs	153.0	0.0
TOTAL	5237.0 MCF	1329.6 MCF

ALTERNATIVE 4

Supply (MCF of roundwood):		Resources Used (MCF of roundwood):
SFLP sawtimber	646.0	439.2
SFLP poletimber	161.0	8.6
PP sawtimber	162.0	0.0
PP poletimber	40.0	0.0
PP dead <5 yrs	245.0	6.2
PP dead >5 yrs	153.0	0.0

consumed in the 5-80 and 80-200 mile zones. The goal of maximizing returns causes allocation of products to the next highest return after consumption can no longer occur in the first zone.

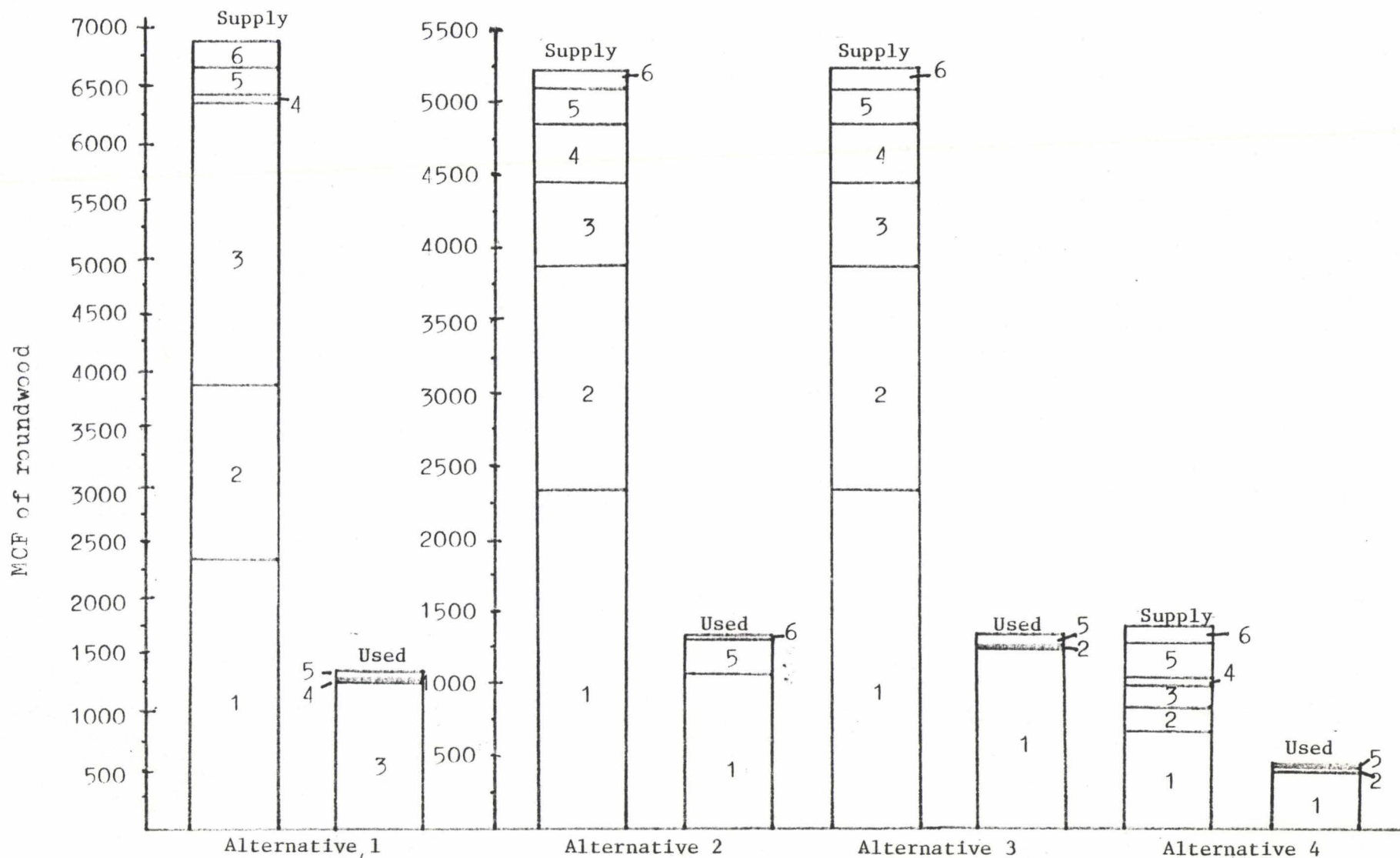
Comparison between Tables VI-11 and VI-20, will show effects of the demand limitation on the consumption pattern and levels of total consumption. The following table is presented as a general indication of the sensitivity analysis pattern for Canon City tributary area:

General Product Consumption Breakdown

Original Alternatives	Sensitivity
0-5 mile zone:	
pallets	pallets
timbers	timbers
boards, rough	boards, rough
fence posts	fence posts
dimension lumber	dimension lumber
firewood	firewood
railroad ties	railroad ties
dunnage	dunnage
5-80 mile zone:	
	pallets
	boards, rough
	fence posts
	dunnage
80-200 mile zone:	
	timbers
	railroad ties

TABLE VI-17 - Canon City-Florence-Penrose: SENSITIVITY STUDY

Raw Material Supply versus Raw Material Consumed



1=Spruce-fir, lodgepole sawtimber
2=Spruce-fir, lodgepole poletimber

3=Ponderosa pine sawtimber
4=Ponderosa pine poletimber

5=Ponderosa, dead 5<yrs.
6=Ponderosa, dead 5>yrs.

Table VI-18 - Canon City-Florence-Penrose; SENSITIVITY STUDY

Total Returns (residual) Distribution Per Market Zone and Alternative

Alternative		0-5 Mile Zone	5-80 Mile Zone	80-200 Mile Zone
1	Total returns	\$23,546.74*	\$137,170.00	\$8,764.80
	Due to PP live	21,184.20	137,170.00	8,764.80
	Due to PP dead	321.30	0.00	0.00
	Due to SFLP	0.00	0.00	0.00
2	Total returns	24,160.64*	153,093.70	15,131.70
	Due to PP live	0.00	0.00	0.00
	Due to PP dead	16,740.30	52,509.70	0.00
	Due to SFLP	5,379.00	100,584.00	15,131.70
3	Total returns	26,654.23*	159,121.60	13,622.40
	Due to PP live	0.00	0.00	0.00
	Due to PP dead	321.30	0.00	0.00
	Due to SFLP	24,291.70	159,121.60	13,622.40
4	Total returns	10,807.24*	68,597.10	2,578.70
	Due to PP live	0.00	0.00	0.00
	Due to PP dead	79.80	0.00	0.00
	Due to SFLP	10,031.70	68,597.10	2,578.70

*Mill residues included in these figures

Table VI-19 Canon City-Florence-Penrose: SENSITIVITY STUDY
Returns to Stumpage (residual)

Alt.	Revenue due to Ponderosa Pine	Revenue due to dead Ponderosa Pine	Revenue due to Spruce-fir- Lodgepole	Revenue due to mill residues	Total Revenue
1	\$167,119.00	321.30	0.00	2041.24	\$169,481.54
2	0.00	69,250.00	121,094.00	2041.24	192,386.04
3	0.00	321.00	197,035.70	2041.23	199,398.64
4	0.00	79.80	81,207.50	695.74	81,983.04

Table VI-20 Canon City-Florence-Penrose: SENSITIVITY STUDY
Market Consumption: Resources to Products (MCF of roundwood)

Alternative 1			Alternative 2		Alternative 3		Alternative 4	
0-5 Mile Zone	Pallets (PP)	31.2	Pallets (D<5)	25.3	Pallets (SFLP)	31.2	Pallets (SFLP)	10.2
	Timbers (PP)	7.8	Timbers (SFLP)	7.8	Timbers (SFLP)	7.8	Timbers (SFLP)	4.8
	Boards R (PP)	43.0	Boards R (SFLP)	43.0	Boards R (SFLP)	43.0	Boards R (SFLP)	12.0
	Fence P (PP)	0.9	Fence P (D<5)	1.5	Fence P (SFLP)	0.9	Fence P (SFLP)	0.9
	Dimension (PP)	5.8	Dimension (SFLP)	5.8	Dimension (SFLP)	5.8	Dimension (SFLP)	3.4
	Firewood (D<5)	24.8	Firewood (D<5)	15.3	Firewood (D<5)	24.8	Firewood (D<5)	6.2
	RR Ties (PP)	15.6	RR Ties (SFLP)	15.6	RR Ties (SFLP)	15.6	RR Ties (SFLP)	1.2
	Dunnage (PP)	31.2	Dunnage (D<5)	25.3	Dunnage (SFLP)	31.2	Dunnage (SFLP)	15.6
	Chips*	342.2	Chips*	342.2	Chips*	342.2	Chips*	115.95
	Sawdust	166.56	Sawdust	166.56	Sawdust	166.56	Sawdust	56.44
Shavings	1.55	Shavings	1.55	Shavings	1.55	Shavings	1.55	
5-80 Mile Zone	Pallets (PP)	281.6	Pallets (D<5)	180.4	Pallets (SFLP)	281.6	Pallets (SFLP)	91.4
	Boards R (PP)	387.2	Pallets (SFLP)	59.2	Boards R (SFLP)	387.2	Boards R (SFLP)	107.2
	Fence P (PP)	7.7	Boards R (SFLP)	387.2	Fence P (SFLP)	7.7	Fence P (SFLP)	7.7
	Dunnage (PP)	281.6	Fence P (D<5)	12.5	Dunnage (SFLP)	281.6	Dunnage (SFLP)	140.8
			Dunnage (SFLP)	281.6				
80-200 Mile Zone	Timbers (PP)	70.4	Timbers (SFLP)	70.4	Timbers (SFLP)	70.4	Timbers (SFLP)	42.2
	RR Ties (PP)	140.8	RR Ties (SFLP)	140.8	RR Ties (SFLP)	140.8	RR Ties (SFLP)	10.4

*Mill residue values are in terms of product, not roundwood.

Recommendations

Previous sections of this report have presented information useful to the development of a mountain pine beetle control program. Steps have been taken to identify potential market areas, and characteristics of those market areas relating to consumption of wood products. Also, production and marketing strategies have been developed and tested based on the raw material available, mill capacities, product potentials and some factor of market demand through use of a goal program. The purpose of this section is to discuss the results of this work and other studies and relate it to a mountain pine beetle control program for the Front Range of Colorado.

Each of the case study areas was found to have a production capacity far in excess of its current level of production. This maximum capacity assumes present production capabilities operated on a full-time basis for all mills in the processing center. The Fort Collins-Loveland processing area has the greatest present level of overall production as well as the greatest potential overall capacity.

Each case study was also found to possess excess supplies of raw material even when maximum production capacities for all products were reached. Thus, each area possesses a capacity to meet some level of increased supply resulting from a beetle-control program. The Colorado Springs processing center had the greatest potential overall supply from ponderosa pine thinning (recommended cut). The Boulder-Longmont area had the greatest potential supply of beetle-killed wood.

Current Level of Beetle-Killed Ponderosa Pine
Utilization and Potential Supply

<u>Processing Centers</u>	<u>Current Use (MCF)</u>	<u>Potential Annual Supply (MCF)</u> ¹
Fort Collins-Loveland	136.0	1,778.0
Boulder-Longmont	141.8	2,333.0
Denver and Suburbs	237.0	696.0
Pine-Bailey	196.5	787.0
Colorado Springs	220.4	973.0
Canon City-Florence-Penrose	62.0	398.0

The table above shows the supply and current level of use of beetle-killed wood in each processing center.

The distribution of accessible timberland, in federal ownership, and state and private ownership will also have an impact on the orientation of a control program along with potential supply in each procurement area. The table below lists the percentages of federal versus state and private ownership of land.

Distribution of Federal versus State and Private Ownership
of Accessible Timberland

<u>Processing Center</u>	<u>Federal</u>	<u>State and Private</u>
	--- Percent of Land Owned ---	
Fort Collins-Loveland	55%	45%
Boulder-Longmont	28%	72%
Denver-Suburbs	57%	43%
Pine-Bailey	50%	50%
Colorado Springs	62%	38%
Canon City-Florence-Penrose	64%	36%

¹ Based on current volume of dead timber distributed over a five-year period.

The level of federal ownership in each case may represent the degree of involvement the U S Forest Service must assume directly in a beetle-control program. In all procurement areas except Boulder-Longmont, federal ownership of accessible timber land is 50% or higher.

The market areas of the individual processing centers were limited in extent only by the products produced. Many products with lower wholesale value simply cannot support transportation costs to distant markets and still yield a sufficient economical return. Therefore, only higher value products can be successfully marketed in more distant zones.

High residual value products from beetle-killed wood that have the greatest potential for marketing are listed below by marketing zone.

High Residual Beetle-Killed Ponderosa Pine
Products by Market Area
(Over \$200/MCF Residual Value)

0-5 mile zone:	fence posts paneling pallets timbers fencing railroad ties	barn poles
5-80 mile zone:	barn poles houselogs corral poles fence posts	paneling pallets fencing
80-200 mile zone:	fence posts paneling railroad ties	
200-900 mile zone:	timbers railroad ties paneling	

This distribution varied somewhat in the sensitivity tests where restricting the local markets caused allocation of some products to their next most profitable market zone.

The list above is an aggregation of all products with a residual over \$200/MCF from beetle-kill pine from throughout the Front Range. In some instances a product does not return as high a residual in certain market zones within a case study and thus the list is not totally applicable to all processing centers. Also, some products listed are not produced in all centers.

Using profit maximization as an overall processing area's goal the computer model attempts to allocate all raw materials to those products which would yield the greatest return in a market zone. The approach can be generalized as finding the product with the highest residual, determining what type of raw material will maximize its residual return, and utilizing that raw material source until it is depleted or the production capacity is reached. The approach begins with the highest value products and works toward the lower value products utilizing the raw material source and capacity for production of that product as it progresses. In each case this total revenue figure was greatly in excess of current total return using present production levels as constraints. In each of these cases the utilization of beetle-killed ponderosa pine also exceeded current levels. This approach or strategy does indicate some possibilities for "growth" in the capacity of dead ponderosa utilization. However, given current levels of production the changes of utilizing the entire recommended cut for dead pine, Alternative 2, is very low.

In comparison, a marketing strategy of utilizing beetle-killed wood as a priority, resulted in a dramatic increase of utilization of beetle-killed wood. In this situation, the computer program strategy is to locate those products which could be made from beetle-killed ponderosa pine and their respective residuals. Allocation of beetle-killed pine supply is first made to those selected products with the highest residual. This continues using

beetle kill products with lower residuals until supply is exhausted. Then, another source of supply such as live ponderosa pine or spruce-fir and lodgepole pine can be used.

In the Fort Collins-Loveland area where beetle-killed supply is high, this study, utilizing maximum mill production levels, resulted in a 1100% increase in use of beetle-killed wood over the current level of usage. In other processing centers the increase was not as substantial but still yielded greatly increased levels of use. In this strategy, profit maximization is not the primary goal yet returns nearly doubled in many cases over the returns at current production.

Overall, the residual return earned from the beetle-killed pine utilization alternative yielded an average of 91 percent of the highest residual return in each case study, usually attributed to Alternative 3. Thus, the loss in revenues attributed to emphasizing a program to maximize utilization of beetle-killed wood, as in Alternative 2, is minimal. It should also be pointed out that the increase in total residual return over the current residual return ranged from approximately 170 to 230 percent of the current level. However, these findings occurred under the assumption that there were no quantity limitations on product markets in any of the marketing zones.

In general, the strategies above resulted in increased utilization of beetle-killed ponderosa pine as compared to the current rate of usage. A program employing the strategy of primary use of beetle-killed as a directive is improbable. However, a program aimed at encouraging the use of beetle-killed timber should be workable.

A number of products have a high profit potential when marketed to certain zones but are not currently marketed there. Some other products, presently produced and distributed widely throughout the marketing region, could be singled out for each case study as primary targets of production due to their high residuals. There could include a mix of all species including beetle-killed timber. This program is based, as previously suggested, on a higher level of overall resource utilization. This step then requires a means of increasing the present level of raw material utilization by mills.

A number of reasons exist for present low level production in light of higher production capacities and greater supplies of raw material. A past history of problems facing Colorado wood products has included the following:

- unsuitable product quality
- limited extent of manufacture of products
- inability to maintain steady flow of product
- lack of standardized grading procedures
- undertermined bias against Colorado products within the state

The degree of present influence of these problems is unknown and was not within the scope of investigation of this study. Possible problems at the processing centers resulting in the above problems are listed below:

- lack of sufficient capital investment in equipment for further manufacture, and lack of capital to maintain present equipment
- lack of sufficient capital to afford stockpiling lumber for future or optimum sale
- low investment in quality personnel
- lack of ability to buy large timber tracts requiring large road building costs

- lack of resources to stockpile raw materials for winter usage when harvest operations are limited by climatic doncitions
- lack of a comprehensive promotional and distribution system for wood products manufactured

Solutions to alleviate the potential problems above may rely heavily on the development of advertising programs to upgrade the quality and utility of Colorado wood products. This might be most effectively approached by building of a representative industry organization to promote the prospects of Colorado-based mills. This type of organization, or the state and federal forestry offices might work to educate the potential consumer in the use of beetle-killed pine products and other Colorado products to counter whatever unfounded bias may exist against their use.

Another large scale approach toward improving Colorado markets would be development of more secondary manufacturing operations. Denver, due to its transportation facilities, network and central location may be a primary candidate for locating this type of operation. Present mill capacity far exceeds production levels in area mills. Current level output of finished product such as planed boards which probide a significant value-added is low. Considering the growth in the Denver area in residential and industrial construction, a market for products of all types, including finished products is readily available but largely untouched by local products. Those firms with finished-stage production have the advantage of a greater number of available markets both locally and out of state. With a more stable position in the industry, a firm may be able to increase its output and capacity to work a greater portion of the year. An approach along the general format suggested here, which has appeared frequently, is for the

development of consolidated mills offering some of the advantages mentioned above or the development of a cooperative planning or dry-kiln operations to produce more valuable finished-stage products.

Another possible method for improving markets for Colorado products, and thus utilization of raw material lies in the development of new product lines, particularly for beetle-killed ponderosa pine. Through CSU Project No. 2191 a number of new products have been suggested as potentials for increasing mill capacities and market penetration. These products include composite panel products. Ponderosa pine was found to be a highly suitable raw material for this product. Based on the performance of other species of dead wood for use in particle board, it was concluded that beetle-killed ponderosa pine would yield a suitable product. However, this possibility requires further investigation.

Plywood is also suggested as a potential product from the Front Range utilizing live ponderosa pine and beetle-killed wood in combination. Many technical aspects of this type of product necessitates further new products in the Front Range is in doubt due to technical aspects of pulping operations and capital outlays required for production.

Laminated wood products is viewed as a product line with high potential for utilization of live ponderosa pine and beetle-killed pine. The advantage to laminated wood production lies in the end result of upgrading the performance qualities of the raw material. Another advantage of laminated wood products lies in the ability to produce them from small diameter raw material which is prevalent in the Front Range.

All of the above-mentioned products would require careful selection of raw material to obtain quality output, especially in reference to beetle-killed ponderosa pine.

GLOSSARY

ProductsPallets

Generally come from lower grades, no. 2 or 3. Common of softwood species. Soundness and bending strength are important. Dry lumber is preferred to minimize warping, splitting, and checking. Treating extends life of the product, particularly if used outside or in temporarily "wet conditions."

Fencing

This product consists primarily of vertical boards, rails, and posts. Slabs from sawlogs and smaller stud longs are the raw materials generally used. This provides an outlet for utilizing what is often a mill residue. Knots are the most important defect to consider. Any lowering of wood strength properties, particularly nail-holding power and bending strength, will reduce service life.

Studs

All logs above five inches minimum diameter are suitable for studs. Their principle use is in the construction industry. Straightness is the most vital characteristic, while other grading criteria include: knots, grain deviation, decay, splits, bark and pitch pockets, checks.

Utility poles

This product is usually used to suspend electric or communication lines. They need to be straight and cylindrical, with gradual taper and free from excessive checks and defects. Utility poles require preservative treatment.

Fence posts

These are used in rural and urban areas for various types of fences. Usually six to eight feet long, two to eight inches diameter at the small end, fence posts are mostly round in cross-sections, although some are squared. Those treated with preservative should have a service life of 35-40 years.

Corral poles

Corral poles are used widely in this region as rails in fencing for cattle feedlots, horse corrals and residential, as an alternative to wire fencing material. Measuring 4-6 inch diameter at the small end and 8-16 feet in length, most are peeled and used untreated.

Barn poles

Generally used in farm, industrial, and residential buildings. Barn poles should have little or sweep, crook or taper. General measurements are 4-6 inch diameter at the small end and 10-25 feet long. Most poles are treated with preservative.

Houselogs

A revival of the houselog in many forms is now being seen throughout Colorado with many structures being built for use as cottages, motels, churches, restaurants, and family residences. Logs are generally 7 inches or larger in diameter at the smaller end and 20-24 feet long. Relatively sound and dry logs are a requirement.

Firewood

Primarily used today as an alternative and supplemental heat source for homes. There is increased use of fireplaces and a high percentage of new living units have fireplaces. Firewood is commonly measured and sold in standard cords, 4 x 4 x 8 feet, or 50-90 cubic feet depending on size and how tightly the pieces are stacked. Occasionally firewood is priced by weight or sold in small units.

Railroad Ties

Railroad ties in this study are treated or untreated and used for decorative, landscaping purposes.

Timbers

Timbers have many construction uses including home, industrial, farm, bridges, auditoriums, stadiums, and mining props. This product generally measures 5 x 5 inches and larger, with the width no more than two inches greater than thickness. Some product is treated with preservatives, other is not.

Dimension lumber

In this study, this product measures 3 x 6 inches. Uses include exposed use in housing and light construction, foundations, decking (roofing and flooring), scaffold planking.

Boards, rough
and planed

Board uses are quite numerous, including interior wall facing, cabinets, shelves, siding, sheathing, farm, crafting, sub floors and so on. A wide range of grades are available for boards, with many characteristics for evaluation. Planed boards are those having finished surfaces as opposed to rough cut surfaces.

Wedges

A product used to tighten mining props, measuring 1 x 4 x 6 inches.

Beams

Used in construction for home, industrial, and farm uses, bridges, auditoriums, stadiums. Generally measure 5 inches and thicker with width more than 2 inches greater than thickness.

Dunnage

Generally used in securing cargo for packing purposes. Finished product measures 4 x 4 feet.

Paneling

6 to 8 inch boards of grade #2 common or better are commonly used. Paneling is a high value product which can yield high returns.

Land Use Classes

Forest land

Land at least 16.7 per cent stocked by forest trees of any size, or formerly having had such tree cover, and not currently developed for non-forest use. (Note: Stocking is measured by comparison of basal area and/or number of trees, by age or size and spacing with specified standards).

Commercial forest land

The current USFS definition is: forest land producing or capable of producing crops of industrial wood and not withdrawn from timber utilization. Areas qualifying as commercial forest land have the capacity of producing in excess of 20 cubic feet per acre per year of industrial wood under management. Currently inaccessible and inoperable areas are included, except when the areas involved are small and unlikely to become suitable for production of industrial wood in the foreseeable future.

Noncommercial forest land

1) Unproductive forest land incapable of yielding crops of industrial wood because of adverse site conditions, and 2) productive-reserved forest land-USFS.

Inaccessible

An area of forest land suitable for timber production but not available because the cost of building access roads is expected to exceed the monetary value of the first timber harvest.

GLOSSARY

Harvest Cut and Raw Material Types

Harvest Cut and Raw Material TypesAllowable cut

The volume of timber that could be cut on commercial forest land during a given period under specified management plans aimed at sustained production of timber products.

Reccmmended cut

Based on an average estimated thinning schedule of 300 cubic feet per acre of ponderosa pine. This value, 300 cubic feet, was the average of estimates obtained from a number of professional foresters from the U.S.F.S. and C.S.F.S. district and state offices. The 300 cubic feet/acre was multiplied by the acerage of ponderosa pine for state and private holdings. National forest thinning volumes were determined with the aid of an accessibility factor and a thinning rate based on stand type. This total volume is harvested over a five year period in equal annual increments as listed in the recommended cuts within each case study summary.

Pole timber trees

Trees at least 5.0 inches in d.b.h., but smaller than sawtimber size - U.S.F.S.

Salable dead trees

Standing or down dead trees that are considered merchantable by regional standards. This term is synonomous with salable dead trees as used in this report.

Mortality trees

Trees, formerly growing stock, dying from natural causes during a specified period, usually annually.

Dead ponderosa pine

Refers to beetle-killed ponderosa pine, dead-standing or dead-down when harvested.

Procurement area

The geographic area from which a processing center can potentially draw its raw wood material. The boundaries of these areas are not absolute. They are subject to change because of changing economic factors. The term tributary area is synonymous with procurement area.

Processing area

An area where products are being, or can potentially be, manufactured. An example is the Fort Collins-Loveland processing center, an area composed of two cities.

Processing center

An inclusive term which means either a processing site or area.

Case study

A report analyzing each processing center and its procurement area. There are six case studies in this project.

Mill residue

Refers to chips, shavings, and sawdust, by-products of mill production operations.

Accessibility factor

Is a percentage used in determining the recommended cut of ponderosa pine for national forest lands. It is arrived by totaling acreages which would not require unprogrammed forest road and trail expenditures. The total is divided by the total number of acres of forest land inventoried in the area. State and private lands are assumed to be 100% accessible, so this factor is not applied in reference to those lands.

Grading System for Boards

A wide range of board grades are available providing grades to meet all specific needs. There are five Common grades and five alternate board grades. The grade levels are not identical but overlap, providing consumers with a broader choice of grade variations. The numerous varieties of species and grades offer boards for many building needs.

The Commons include #1, #2, #3, #4, and #5 Common. Alternate board grades (2 inches and wider, 1 1/2 inch and thinner) include Select Merchantable, Construction, Standard, Utility, and Economy. Characteristics important in determining grade include stain, checks, torn or raised grain, warps, skips, crooking, split, pitch and bark pockets, and knots. The extent of these deficiencies, particularly knots, in relation to surface area under consideration is also important in determining grade.

APPENDIX

Conversion of Raw Material-MCF of Product to MCF of Roundwood

Timber Class		MCF OF P→MCF OF R MULT FACTOR	\$/MCF OF P→\$/MCF OF R MULT FACTOR
Pallets	sawtimber	2.0	0.5
Timbers	"	2.0	0.5
Fencing	"	2.0	0.5
Boards	"	2.0	0.5
Houselogs	poletimber	1.0	1.0
Barn poles	"	1.0	1.0
Corral poles	"	1.0	1.0
Fence posts	"	1.0	1.0
Panelling	dead<5 ¹	1.625	0.615
Demension lumber	sawtimber	2.0	0.5
Studs	"	2.0	0.5
Firewood	dead>5 ²	1.0	1.0
Railroad ties	sawtimber	2.0	0.5
Utility poles	"	2.0	0.5
Beams	"	2.0	0.5
Wedges	poletimber	1.0	1.0
Dunnage	sawtimber	2.0	0.5

1/ dead<5 is Ponderosa pine material of any commercial size dead less than five years.

2/ dead>5 is Ponderosa pine material of any commercial size dead greater than five years (used exclusively for firewood)